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A.

CHEMICALS AND CHEMICAL INDUSTRY.

J. LAWRENCE SMITH.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

CHEMICALS IN GROUP III:

CHEMICAL INDUSTRY.

BY

J. LAWRENCE SMITH,

MEMBER OF THE SCIENTIFIC COMMISSION OF THE UNITED STATES.

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CHEMICALS IN GROUP III:

CHEMICAL INDUSTRY.

1. All articles coming under the head of chemical industry were included in Group III of the exposition, and were divided into four sections:

1st. Those including the heavy products of chemical industry, as sulphuric acid, soda, potash, and salts;

2d. Pharmaceutical and finer chemical products;

3d. Products from fats and oils;

4th. Products from dry distillation;

5th. Coloring matters, pyrotechnical products, and miscellaneous chemicals.

In our report we will glance over the improvements which have taken place in the industry of these different substances since 1867, when the writer made a report on the same subject to the United States Government, or at least such of them as we find have been improved upon, either in quality or in the process of manufacture.

SULPHURIC ACID.

2. During the past six years, the quantity of sulphuric acid produced has increased by one-half of what it was in 1867; and the production of it by iron pyrites is replacing more and more every day the use of sulphur, and consequently the immense deposits of pyrites in different parts of the world are being worked with more energy than ever.

The improvements also in the manner of burning the pyrites have been very marked, principally by heating the pyrites in thinner layers and on several shelves, passing the heated vapors of sulphurous acid under the lower shelf, thus economizing the heat and burning out the sulphur more completely; so much so as to leave only 1 per cent. of sulphur in the residue.

In Belgium, the works of Messrs. Hasenclever & Hebig are now using zinc-blende for making sulphuric acid, utilizing as much as 80 per cent. of the sulphur in the blende.

Improvements have also been made by Laming in condensing the sul-

phur of illuminating-gas more effectually, and using the residue in the manufacture of sulphur.

Several improvements have been made in the manner of concentrating the acid from the lead-chambers to 60°; but the most important, in view of its economy, is that by which the waste heat of the pyrites-furnace is made to operate in the lead-pans in which the concentration takes place, for it has been well established that the heat lost in the ordinary method of operating these furnaces is more than sufficient for the purpose.

What is now well known as the Glover-tower in sulphuric-acid factories is being rapidly extended. It is used for the double purpose of condensing the waste vapors of sulphurous and nitrous acids, and returning them to the lead-chambers, concentrating the acid at the same time.

In the final concentration of the sulphuric acid, none of the many devices proposed seem to replace the platinum still, notwithstanding its great original cost. Efforts have been made to economize the amount of platinum required to produce a given result. Messrs. Tame & Kepler exhibited the drawing of an apparatus by which the acid is made to flow over a series of shallow platinum vessels, heated directly by the fire, and covered with a lead vessel, which is kept cool and condenses the vapor arising from the heating of the acid. One apparatus, costing $5,000 or $6,000, is said to accomplish the work of an ordinary still costing $20,000.

SODA.

3. No novel method was exhibited for the manufacture of carbonate or caustic soda. The best methods in use were, however, illustrated, as they are becoming extended more and more among manufactories. Such are complete condensation of the hydrochloric acid, and the substitution of lead for iron in forming the pans for evaporation. One reason for seeking to recover more completely the hydrochloric acid is the extended use of this acid in the chemical arts, and none of these applications are more important than that to the recovery of sulphur from the waste of the soda-ash.

The manufacture of soda from the mineral cryolite is conducted in the same way as was fully set forth in my report of 1867.

The method called the ammonia method, exhibited in 1867, has been perfected to such an extent by Solvay & Co., of Couillet, Belgium, that it bids fair to replace in many localities the manufacture of soda by the Le Blanc process. The above manufacturers make annually 5,000 tons, and the product competes successfully with the soda made by the Le Blanc method. Many factories are going up in different countries for the manufacture of soda by this process, which is also likely to be introduced successfully into this country.

For the production of 100 pounds of soda by this process, (soda of 90 per cent.,) the following is a statement of materials expended. From this the cost may be calculated.

	Pounds.
Charcoal	250
Coke	50
Salt	200
Limestone	100
Sulphuric acid	10
Sulphate of ammonia (lost)	2

Labor, about 50 cents.

CHLORIDE OF LIME.

4. The principal improvement in the economical manufacture of this product is the restoration of the oxide of manganese used in manufacturing the chlorine, which is simply changed in form, remaining among the residues that were formerly thrown away. It was successfully recovered in 1867; but the processes have been much improved since then, and have all been fully described in works on technical chemistry.

POTASH SALTS.

5. The industry of the salts of potash has acquired a wonderful development since the commencement of the exploration, in Prussia, of the natural deposits of potash salts at Stapfurt. To furnish some idea of the extent of this new chemical industry, the following statistics are given in relation to the works at Leopoldshall.

In 1872, there were thirty-three works, consuming 514,000 tons of potash salts from the mines, employing 1,100 miners and 3,000 workmen, and having 120 boilers, and steam-engines of 1,500 horse-power, making 50,000 tons of nearly pure chloride of potassium, 63,000 tons of potash manures mixed with common salt and sulphate of magnesia, 2,500 tons of sulphate and carbonate of soda, 12,500 tons of sulphate of magnesia, 7,000 tons of sulphate of soda, 20 tons of boracic acid, and 1,000 pounds of bromine.

PHOSPHATIC MANURES.

6. The manufacture of these manures has largely increased, owing principally to discoveries of large deposits of phosphate of lime, and the various forms of phosphatic concretions. The methods of preparing them are of the same nature as those long in use, and much of the increased product of sulphuric acid is used in this direction.

PHARMACEUTICAL AND OTHER PRODUCTS.

7. Under the second division of chemical products was included pharmaceutical products properly speaking, and raw materials used in pharmacy, also essential oils and perfumes. While the display in these different departments was extensive, there was nothing new since the exposition of 1867, either in product or process. Some of the known processes had been improved so as to yield purer and more abundant products from some of the raw materials.

Under this head, the United States exhibited some handsome specimens

of both raw materials and manufactured products, and special notice was taken of the great perfection of the apparatus for making aerated waters sent from this country.

The raw materials and the chemistry of the oils and fats were well illustrated. In the class of raw materials, the United States exhibited a number of fine specimens of cotton-seed oil from two houses in New Orleans; but this country was not represented in solid animal fats to a degree commensurate with her important commercial position in this respect.

This was in some degree compensated by diagrams and drawings of everything pertaining to the slaughtering of hogs in Cincinnati, Saint Louis, and other western cities.

In mineral oils, which embrace the various products from petroleum, the United States outranked all other countries, and, in fact, it was clearly shown that the rest of the world depend, at the present time, upon our country for the large amount of this oil now needed.

In the manufacture of what is known as candle-stuff, viz., stearic acid, there was no improvement on processes which were fully elaborated in the report of the writer on the Paris exposition of 1867.

ARTIFICIAL COLORING STUFFS.

8. In this class of chemicals were embraced principally all coloring materials obtained from mineral substances subjected to various processes, and what are known as the tar-colors; colors manufactured, by chemical processes more or less complicated, from the materials obtained by distillation from coal-tar.

The most noted process in those known since 1867 was the supplanting of iodine in some of the processes by nitrous acid, allowing that valuable medicinal agent, iodine, to recover its former price in the market. Its extended use in these colors had more than quadrupled its price in the space of two or three years.

The most important discovery, however, in these tar-colors was the production of a new one from a portion of the distillate of coal that had been rejected as refuse, and, strange to say, it may be said to be the most important of these colors.

It is alizarine, a red coloring matter, identical with that from the madder-root. The substance from which it is made is among the heaviest distillates of coal tar, and is called *anthracene.* It is difficult to estimate its commercial value; for already one-half of the madder-root required has been substituted by this alizarine. It furnishes as beautiful, as varied, and as fixed colors as the best madder.

A vast variety of other materials were exhibited in this group, but none of them was of any more marked importance than those exhibited in 1867.

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B.

VIENNA BREAD.

E. N. HORSFORD.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

VIENNA BREAD.

BY

E. N. HORSFORD,

MEMBER OF THE SCIENTIFIC COMMISSION OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
Sm 1875.

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APPENDIX A.

APPENDIX B.

ERRATA.

Page 9, line 39: For "hydroscopic" read "hygroscopic."
Page 14, line 31: For "that" read "which."
Page 17, line 1: For "Walzenmühle" read "Walzmühle."
Page 38, line 2: For "lower" read "upper or running."
Page 38, line 3: For "upper or running" read "lower."
Page 38, line 4: For "curves" read "grooves."
Page 44, line 16: For "Walzenmühle" read "Walzmühle."
Page 49, line 16: After "diagrams" insert "from Kick."
Page 86, line 25: For "acetic and" read "acetic or."
Page 86, line 27: For "any" read "in the presence of."
Page 86, line 28: For "so also" read "so is also."
Page 105, line 20: For "ash" read "total wheat;" and over "lime" insert "The total ash contains."

VIENNA BREAD AT THE INTERNATIONAL EXHIBITION.

CHAPTER I.

THE GRAIN OF WHEAT; ITS CHARACTERISTICS.

1. Foreigners visiting the Austrian capital find at every hotel and restaurant the *Kaiser-Semmel*, a smooth, irregularly-rounded, small, wheaten-flour loaf, or roll, of uniform weight, and always fresh, but not warm. It presents a rich, reddish-brown crust, and a delicately-shaded, yellowish, almost white, interior. It is always light, evenly porous, free from acidity in taste or aroma, faintly sweet without addition of saccharine matter to the flour or dough, slightly and pleasantly fragrant, palatable without butter or any form of condiment, and never cloying upon the appetite.

2. This wheat-bread of Vienna has long been famed for its excellence. As produced at the Paris International Exposition in 1867, it elicited universal admiration. The products of the French bakery were, at their best, plainly inferior to the steady, uniform achievements of the Vienna bakery. The proprietors of the latter, when asked what was their secret, replied: "We have none; we use Hungarian flour and press-yeast, and these constituents are manipulated with cleanliness, care and intelligence."

The uniformity of the product demonstrates that the problem of making good bread has been solved. One wonders why such bread cannot be elsewhere obtained. It is known that efforts have been made to introduce the production of the Vienna bread to the public of other countries, but with indifferent success. The trained journeymen-bakers of Vienna are sought for and obtained to serve in other capitals; but the bread they produce is inferior. Why have these efforts failed? Why cannot so apparently simple a process be communicated to others in such terms as to be followed?

To answer this question, the bakers of Vienna determined to give every facility to the visitors at the Exposition to see, if they desired, all the processes essential to the production of their bread. To illustrate the art, they caused a comprehensive bakery, with all needed appliances, to be set up within the grounds of the Exposition, and maintained in full operation from the opening to the close, turning out, day by day, the *Semmel-Brod*, (table-rolls,) loaves of wheat-bread, rye-bread,

mixed wheat and rye bread, and numerous forms of biscuit, pastry, cake and confectionery having a basis of flour.

The shelves of the show-room presented the peculiar styles of products to be met with in the different districts of the Austro-Hungarian empire. This extensive bakery was intrusted to the direction of Roman Uhl, of Vienna, court-baker, and the author of various papers on flour, bread and baking.

3. In the study of the processes which, in all their detail, were here laid open to the international jury, as well as to all others interested in the manufactured products of flour, it became apparent that an intelligible report upon the Vienna bread must include a report upon the art of *milling* as practised under the improved methods now pursued in Austria and Hungary, from which latter country the finer Vienna flour is for the most part drawn; and this must be preceded by an account of the structure of the grain of wheat, upon which the philosophy of the improved milling rests. The report must also contain an account of the chemical composition of the grain and flour, and their susceptibilities to climatic influences and to the various agencies of deterioration, and an account of the methods of purification and preservation, upon a knowledge of which the production of the uniformly excellent flour in a large degree depends. It must consider the peculiarities of Hungarian wheat. It must also embrace the history of the improvements in the agencies for rendering the bread porous and free from acid taste or odor, and lastly, present what is essential in the art of baking.

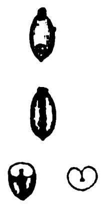
These necessities being recognized, no apology will be required for the attempt to present any details that may enable us to profit by the Vienna exhibition of the art of making bread. They will be confined to the art of making white porous bread from wheat.

Fig. 1.

4. THE GRAIN OF WHEAT.—The grains or kernels or berries of different varieties of wheat vary from each other slightly in form, but are in general irregularly oblong oval, having a deep groove extending from end to end on one side, which gives to a cross-section a surface bounded by three rounded angles. At one end of the berry is the brush of vegetable hairs; at the opposite extreme, under an irregularly-curved surface-layer of bran technically called the shield, is the embryo. In the accompanying cuts we have, in Fig. 2, at the left, the average normal size of the berry, and, in Fig. 1, the same under a power of six diameters, which illustrate the parts referred to.

If the blade of a sharp knife be passed through the berry midway between the two ends and perpendicularly to the axis, there will be presented a section, which, under the microscope, will show an exterior envelope of several layers; an interior envelope, consisting of cells, and their contents of gluten and phosphates, constituting the most nutritious portion of the berry; and a mass of white, consisting of loose cellular

tissue supporting a vast body of starch-granules, with clusters of cells of albuminoid matter, extending to the heart of the berry. The accompanying diagram,* at the right, which is a cross-section magnified to eighteen diameters exhibits the relative thickness of the outer coats, the gluten and phosphate coat, and the mass of starch and albuminoid cells within, and also the peculiar looped outline of the longitudinal groove on one side of the berry.



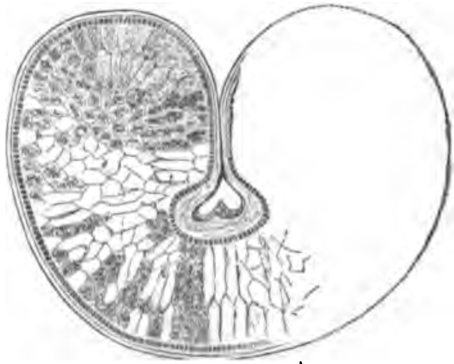


Fig. 2.

5. TRUE BRAN.—If grains of wheat be moistened with water, and rubbed between the folds of a rough cloth, the outer covering may be readily detached. This is composed of two layers, constituting about 3.5 per cent. by weight of the plump unbranned berry. To these layers are attached the vegetable hairs, or beard, at the end of the berry, opposite the embryo. When the dried hulls separated by the rough cloth, are burned, they yield 6.64 per cent. of ash, in which I have recognized, besides the phosphoric acid, notably silicic acid, iron, lime, magnesia, and potassa; of the ash, 7.70 per cent. is phosphoric acid.

6. If the berry, after having been thus hulled, be treated with a solution of alum and then with weak acetic acid, on opening it with a sharp knife along the curved surface on the side opposite the groove, digesting with warm water and subjecting to gentle pressure, the starch and imbedded albuminoid bodies may be quite wholly separated, leaving a layer of cells containing gluten and phosphates, attached to or constituting a part of the inner bran-coat. These inner bran-coats may then with care be successfully freed from the gluten by maceration and gentle pressure. They consist of the honey-combed frame-work of cellular tissue, from which the cells, or sacs, containing the gluten and phosphates have been removed, and the outside layers of envelope not separated with the rough cloth. The weight of these together, including that portion of the outer coats of bran lying within the loop of the groove, shown in Fig. 2, dried at 212° Fahrenheit, is about 12.5 per cent. of the weight of the whole berry. In the ash of all these coats, phosphoric acid, alkaline earths, and alkalies are recognized.

7. In the accompanying diagrams, Fig. 3 illustrates the relative positions of the several layers of the investing coats of the berry, as seen from without; Fig. 4, as viewed in a section transverse to the greater

*An absolute portrait, prepared by Mr. Thomas J. Hand, of New York, to whom I am indebted for most of these drawings illustrating the structure of the wheat-grains.

length of the berry; Fig. 5, as presented in longitudinal section. 1, 1 are the outer coats of the bran proper. They are made up of two layers of flattened longitudinal cells. Mégé Mouriès includes both under the name *sarcocarp*, giving to the cuticle or outer wall of the outer layer the name *epicarp*. 2 is the inner coat of bran proper. It is made up of trans-

Fig. 3.

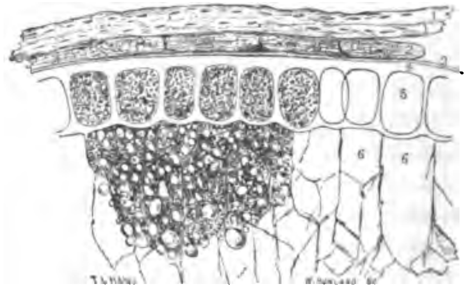


Fig. 4.

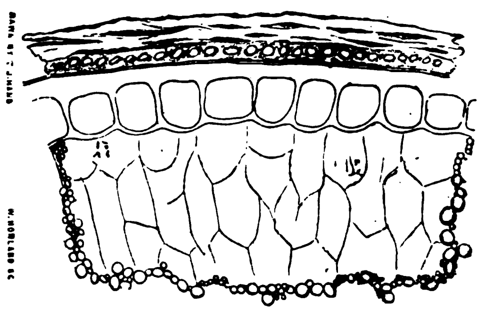


Fig. 5.

verse tubes, which, from their arrangement side by side, have suggested the convenient name of *cigar-coat*. The tubes of which this coat is made up have been found by Mr. Hand, in an examination of the residuum of bran after passing through the alimentary canal of a heifer, to be *spiral vessels*. It is the *endocarp*, or fruit-coat of Mégé Mouriès. 1, 1, and 2 together constitute the pericarp of Trècul. 3 is seed-skin, called variously *episperm*, *testa*, and *primine*. In it are the granules of coloring-matter, which determine whether the wheat is red or yellow, or, in their absence, white. 4 is the inner membrane, or *secundine*, the comb-coat, in which are set the gluten-sacs 5, which contain cells holding the gluten and phosphates. 6 is the loose cellular frame-work of the interior, in which are the starch and the imbedded groups of cells containing albuminoid bodies.

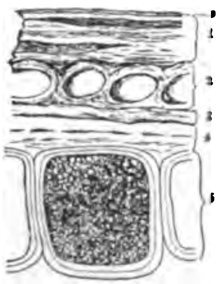


FIG. 6. Portion of radial (or longitudinal) section, 400 diameters.

Fig. 6.—The gluten-sacs have an average diameter of about $\frac{1}{675}$ of an inch; and the granules of gluten about $\frac{1}{15000}$ of an inch.

The beaded outline of the transverse cells of the cigar-coat, as well as

that of the longitudinal cells of the two exterior coats, seems to point to a common structure.

In Fig. 3, the outer coat only was in focus when drawn. The outline of the cells of the inner coat is indicated by shaded lines. Careful microscopic examination shows all these cells to have been tubes, as is indicated in the cigar-coat in Fig. 6.

8. Exposing the whole berry for a few hours to water will cause the outer cells to swell up and appear in cross-section somewhat like, but more flattened than those of the cigar-coat shown in Fig. 6.

Traces of the tubular structure of the longitudinal cells are seen in both Fig. 4 and Fig. 5. One sees, too, not unfrequently, traces of bars across the cells from one bead to its opposite fellow, in a direction slightly oblique to the perpendicular to the axis of the cell. Each bead is seen to be double where two cells lying side by side are seen from above, and a wall of partition is traceable throughout the whole chain. As Mr. Hand has had the fortune to resolve into elastic coils the cells of the cigar-coat, and as it has happened to me to observe them in all perfection in the outer coats of a longitudinal section through the groove and near the embryo, some of them uncoiled in part in the preparation of the section, it seems very possible that these double beads are cross-sections of the two adjacent spiral threads of two adjacent spiral vessels; and that the three coats—that is, the two outer coats of longitudinal cells and the interior cigar-coat of transverse cells, all of which are tubes—were originally so many layers of spiral vessels. The outer cells are flattened, and the traces of the coils of the spiral vessels for the most part obliterated, though the beads which are cross-sections of the double threads, are very distinctly preserved.

According to this view of the structure of the shell of the wheat-grain, the epicarp of Mégé Mouriès is merely the contiguous outer walls of the outer layer of longitudinal spiral vessels, the divisions between the coils of which have been in a large degree obliterated. The sarcocarp, which, with Mégé Mouriès, includes the two coats of longitudinal cells minus the outer wall of the outer coat, (called by him the "epicarp,") should apply only to the inner layer, or mesocarp, and epicarp should apply to the outer layer. Then the cigar-coat will be the *endocarp*. These three belong to the *fruit*-coat, the next two to the *seed*-coat, and all five are exterior to the layer of gluten-sacs and belong to the shell of the grain. Ordinary miller's bran includes these, and carries with them the layer of gluten-sacs in addition, and traces of adhering white flour.

Proceeding from without inward, we should have, as seen in Fig. 7—

Fruit-coats.
- 1st. The epicarp, or outer coat of longitudinal cells.
- 2d. The mesocarp, or inner coat of longitudinal cells.
- 3d. The endocarp, or coat of transverse cells—the cigar coat.

Seed-coats. { 4th. Episperm, testa, outer seed-coat, or color-coat.
5th. Tegmen, inner seed-coat, or gluten comb-coat, consisting of almost obliterated cells. }

6th. Layer of gluten-sacs, or perisperm.

7th. Interior mass of white, consisting of irregular cells containing starch and albuminoid bodies, the endosperm.

Fig. 7.

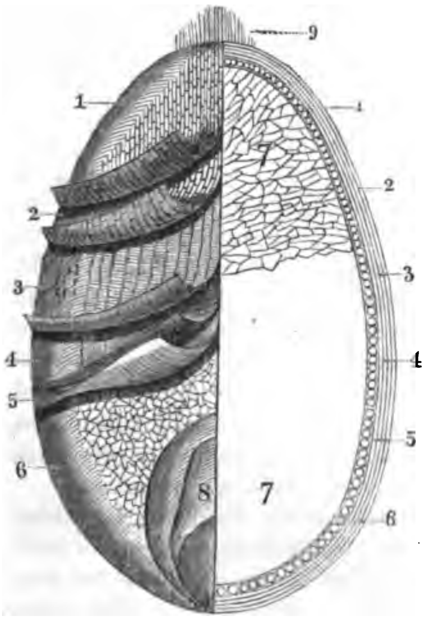
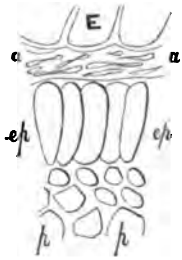
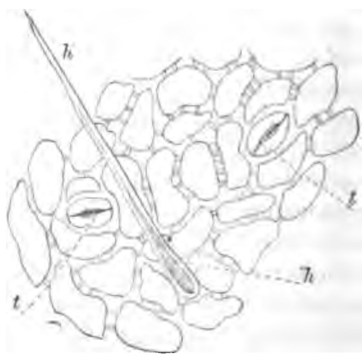


Fig. 8.



Portion of the epithelium (*ep.*, *ep.*) of the shield, and the neighboring tissues: *p p*, paranchyma of the shield; *a a*, layer of collapsed cells on the border of the endosperm.

Fig. 9.



Portion of the outer coat at the end opposite the embryo, with its openings, *t t*, and one of the hairs, *h*, (Vogel.)

At one end, under the shield, 8, are the foreshadowed future plumula and radicle of the embryo. At the other end are the hairs, 9, and occasional openings in the epicarp, as shown in Fig. 9.

Figure 8 presents a greatly magnified section of a minute portion of the tissues of the embryo bordering upon the more interior parts of the kernel.

9. Chemical composition of the berry.—If the kernel of wheat be divided in halves by a sharp blade passing through the grain at right angles to the groove, and one of the surfaces so exposed be subjected to the action of a solution of iodine, it will assume a purple hue, sharply bounded by the gluten-coat, the color of which will be unchanged, showing that the great mass of the interior of the berry is starch. If the other surface be subjected to the action of a solution of blue vitriol

in ammonia (ammonio-sulphate of copper,) the starch of the interior will not be changed in color, but the gluten-coat will have become green from the formation of phosphate of copper. The gluten will also readily absorb red cochineal in solution, while the starch will remain unchanged.

If we take the half of a plump kernel as before, and carefully detach with the point of a needle the starch from the interior, there will remain a cup, the lining of which will be a continuous layer of gluten-sacs set in a comb of cellular tissue, tenaciously binding the sacs together. If this material removed from the interior be burned, the ash remaining will be inconsiderable in amount; but, if the cup be burned, the percentage of ash will be large.

10. A series of fifty-six samples of wheat from various countries gave a percentage of ash from the grains, or berries, dried at 212° Fahrenheit, of from 1.7 to 3.13, with an average of a little less than 2 per cent., almost the whole of which must reside in the 15.5 per cent. of weight of the investing coats of the berry, including the outer and inner bran and the gluten-coat.

The following table may be taken as exhibiting a fair average analysis of the ash of good wheat:

Potassa	30.00
Soda	3.50
Magnesia	11.00
Lime	3.50
Oxide of iron	1.00
Chloride of sodium	0.50
Sulphuric acid	0.50
Silica	3.50
Phosphoric acid	46.50
	100.00

11. The distribution of the materials of this ash is not uniform. The 15.5 per cent. of the investing coats contains much the larger part.

In an analysis of the A grits of the Pesth *Walzmühle* (cylinder or roller mill,) which, as will be seen farther on, may be taken as representing rather more than the average white interior of the berry, exclusive of the gluten-coat, it was found to contain but 0.42 per cent. of ash. Giving to the 3.5 per cent. of outer bran-coats of the total kernel, the ash as found at 6.64 per cent., there would remain, as shown by calculation, for the gluten-coat, a percentage of ash = 11.33.

Thus, 3.50 per cent. of 6.64	0.230
And 84 per cent. of 0.42	0.353
There remains for 12.50 per cent. of 11.33	1.417
To make the total ash	2.000

12. The relative proportions of the ingredients of the ash vary somewhat with the physical qualities of the berry.

Ritthausen has found that the hard or flinty varieties of wheat contain an excess of total ash, and in the ash an excess of phosphoric acid as compared with the potassa, and the reverse in soft varieties. In the former, the ash is 2.18 per cent.; in the latter, 1.94 per cent. In the former, the phosphoric acid is to potassa as 51.79 : 33.01; in the latter, as 46.43 : 37.31.

13. The other constituents vary in some sixty analyses that have been compared as follows: Soda, from 0.75 per cent. to 17.79; magnesia, from 7.82 per cent. to 16.27; lime, from 1.07 per cent. to 8.21.

From the researches of Dempwolff it appears that the percentage of lime is greater in the outer coats, while that of the magnesia is greater in the interior portions of the berry. The percentage of potassa is also larger in the interior.

The analyses of the products of the Pesth *Walzmühle* have shown that the phosphoric acid, as will be seen farther on, is in greatly-increased percentage in the investing and gluten coat.

14. The ratio of the ash of the interior to that of the whole grain, weight for weight, would be as 0.42 : 2.00, or nearly as 1 : 5. The ratio of the ash of the interior white portion to the ash of the investing coats, weight for weight, is as 0.42 : 11.33, or nearly as 1 : 27.

15. In view of the above, it is obvious at a glance that, as the interior of the berry contains so little ash, the flour owes its mineral ingredients, when it contains them in considerable proportion, to what it derives from the interior investing coat—the coat containing the sacs of gluten and phosphates. These sacs, detached from the gluten-coat, carry with them the mineral constituents they contain to the flour. It is obvious at a glance, also, that a system of milling is better, generally speaking, in proportion as it contributes from the bran the sacs of this inner coat containing the gluten and phosphates, while leaving behind all that lies outside of this gluten-coat.

16. PROXIMATE CHEMICAL INGREDIENTS OF THE WHEAT BERRY, OR GRAIN.—The investing coats of the berry, including the comb holding the gluten-sacs, consist chiefly of cellular tissue with inorganic salts, mainly phosphates, and small proportions of substances allied to gluten and oil.

17. *Gluten.*—If a handful of flour be moistened and made into dough, and then kneaded in a gentle stream of water until the water runs from the dough clear, the substance that remains when dried is known as gluten, and in its moist condition weighs from 25 to 50 parts of the 100 parts of the flour taken. In its dried condition, it weighs but from 10 to 15 parts. This substance is elastic, tenacious, and possesses the property of absorbing and holding a large percentage of water. When spontaneously dried in the air, it is, chemically speaking, a hydrate, which parts with its water of hydration on the application of heat, which water is re-absorbed from the air on cooling. This property of gluten is of importance, as will be seen farther on in the explanation of

the changes fresh bread undergoes in becoming stale, and which take place in the production of toast.

18. *Starch.*—The water that has flowed from the dough in the process of kneading contains, in suspension, the *starch*-granules, and also more or less gluten-cells, which, on standing, settle to the bottom.

19. *Vegetable albumen.*—If the clear liquid above the deposit of starch be poured off and heated to boiling, a foam will appear on the surface, which will collect in the form of gray flakes, strongly resembling coagulated albumen, (white of egg.)

20. *Sugar and dextrine.*—After separating this albuminous substance by filtration, and evaporating the fluid, at a temperature not exceeding 212° Fahrenheit, to the consistency of a sirup, it will be found to be sweet to the taste, showing the presence of *sugar*, (glucose,) and will be found also to contain a body allied very nearly in its properties to *dextrine*, (mucilage.)

21. *Vegetable fibrine and caseine.*—If the crude mass of moist gluten be treated first with weak and then with stronger alcohol, a portion will dissolve, leaving a grayish residue, to which the name of vegetable *fibrine* has been given. The solution in alcohol, on being heated, yields on cooling a deposit of substance having many properties in common with *caseine.*

22. *Glutin.*—If the alcoholic solution be evaporated to the consistency of a sirup, and then water be added, a body of pulpy consistency is separated, which has many properties in common with the albuminoids, already mentioned, but also some properties in common with animal gelatin, justifying a separate name, and it has been called *glutin.*

23. *Oil.*—With the glutin is also separated a fatty body, or oil, of the consistency and melting-point of butter, which may be readily extracted with ether. It is more abundant in the embryo and tissues immediately about it.

24. Besides these nitrogenous compounds, all of which contain phosphates of iron, magnesia, lime, and the alkalies, as well as compounds of sulphur, (sulphates?) another kindred body has been recognized by Mégé Mouriès, which he has called *cerealine*, chiefly found in bran, and which seems to be distinguished from its fellows by greater susceptibility to spontaneous decomposition when moistened and warmed, and a capacity to rapidly liquefy starch. The collective name *aleuron* has been given to all the organized bodies containing nitrogen.

25. To all of these is to be added water in a form that is in part hydroscopic.

26. The proximate analysis of wheat gives us the following constituents: 1. Cellular tissue; 2. Woody fiber; 3. Phosphates, with traces of sulphates, chlorides, and occasionally silicates; 4. Albumen; 5. Fibrin; 6. Caseine; 7. Glutin; 8. Cerealine; 9. Starch; 10. Sugar; 11. Dextrine; 12. Oil; 13. Water.

Oudemans found in 100 parts of wheat-berries—

Starch	57.00
Dextrine	4.50
Nitrogenous substances, soluble in alcohol but insoluble in water	0.42
Coagulable albumen	0.26
Albumen soluble in water and not coagulable, two kinds	1.55
Fibrine	9.27
Oil	1.80
Woody fiber	6.10
Ash	1.70
Extractive matter	1.40
Water	16.00
	100.00

Poggiale found in Egyptian wheat 7.855 per cent. of woody fiber; and, including cellulose and cellular tissue, Polson accredits to a Scotch variety 12.4 per cent.

Alexander Müller found the proportions of component constituents to vary in the wheat-berries grown in the same year and in the same field according as the heavier grains or lighter were taken. Separating the product of pure grain into two parts such that equal volumes weighed in the ratio of 76.75 : 52.55, he obtained from 100 parts of each—

Water	15.65	15.56
Woody fiber	2.54	6.04
Ash	1.57	1.80
Nitrogenous substance	11.84	12.97
Oil	2.61	2.39
Sugar	1.41	2.40
Starch	64.38	58.84

From the above, it is apparent that the heavier grain contains more starch, but less of nitrogenous substance, sugar, and woody fiber.

27. To the above may be added a table embracing results showing how greatly the composition of the wheat-berry is influenced by differences in season, soil, climate and variety:

Authorities.	Names of varieties.	Water.	Starch.	Fat.	Cellulose, (woody fiber, cellular tissue.)	Gum and sugar.	Nitrogenous substances.	Nitrogen.	Ash.	PO_5.	SiO_2.
Falling & Faisst *	Winter-wheat, (Würtemberg)	14.78	31.95		2.84		13.24		1.97	0.71	0.14
Millon †	Twenty-two samples from Lisle, Algeria, and Odessa.	12.01–17.70		1.41–2.14	1.40–2.35		9.92–13.81	1.59–2.73			
Polson ‡	Old American	10.8	62.3	1.2	8.3	3.8	10.9		1.6		
	New Scotch	14.8	56.9	1.2	12.4	5.3	7.0		1.5		
Poggiale §	Mean of samples not specified	14.5	63.3	1.9	4.2		17.4		1.7		
Mayer ‖	Summer-wheat	13.47						2.29	2.19	1.18	
	Winter-wheat, nine samples	10.97–13.83						2.01–2.32	1.89–2.36	0.93–1.16	
Horsford ¶	Talavera wheat	15.43					13.98	2.59	2.80		
	Whittington wheat	13.93					14.72	2.68	3.13		
	Sandomiertz wheat	15.48					14.51	2.69	2.40		

* Dingler's Polytechnisches Journal, cxxiv. The moisture was determined in the fresh grain. The other constituents in the grain were dried at 212° Fah.

† Compt. Rend., xxxviii. Amount of dry gluten in the nitrogenous substance varied from 6.0 to 7.04. (?)

‡ Chem. Gaz., 1855, p. 211. The determinations refer to the grain in its ordinary (undried) state.

§ J. Pharm., (3), xxx, 180, 25. The determinations refer to the substance dried at 248° Fah. The water was determined by heating to the same temperature. The starch includes gum or dextrine.

‖ Liebig's Annalen, ci, 129. The water was determined in the air-dried grain; the other materials in the grain dried at 212° Fah.

¶ Liebig's Annalen, 1846. The nitrogenous substance was calculated from the percentage of nitrogen in the air-dried condition.

28. NITROGENOUS BODIES.—The organic elements of the several nitrogenous bodies in the foregoing tables are not only the same, but are substantially in the same proportions. The average analyses yield—

Carbon	53.5
Hydrogen	7.0
Nitrogen	16.0
Oxygen, phosphates and sulphates	23.5
	100.0

29. The sulphates and phosphates vary in quantity and proportion much from each other, and are doubtless connected with the chemical and physical qualities of the different nitrogenous substances of which they constitute a part.

30. GLUTEN may be estimated either moist or dry, as already pointed out. The average of nine varieties from different countries in Europe, determined long since by Vauquelin, gave for the moist gluten 25.57 per cent. of the flour, and for the dried 10.69 per cent.

The determinations of the percentage of moist gluten in the flour from certain varieties of wheat exhibited at the International Exhibition of 1873, made by Franz Schmidt of Langendorf near Vienna, a member of the international jury, gave the following results:

Varieties of wheat-flour:	Percentage of moist gluten in the flour.
Flour, by the process of high milling, from the Vienna Fruit and Flour Exchange	37.5
Flour, by the process of low milling, from the German Collective Exhibition	25.5
Extract flour, from Economo, in Trieste	44.25
Flour of the Hungarian Collective Exhibition	37.0
Flour from Banadura wheat from Russia, by A. Bakhrameiff	48.65
Flour from Liaschkoff, (from white wheat)	35.3
Flour of G. C. Thilenius, Cape Girardeau, Missouri, (from American white wheat)	32.5
Flour from the hard wheat of Algiers	32.5
Italian flour from Besareth in Ancona	25.0
Spanish flour	30.0
Japanese flour	37.5

31. Von Bibra analyzed the gluten obtained from several varieties of flour, and found the proportions of vegetable fibrine, gelatine, and caseine to be as shown in the accompanying table:

Ingredients.	Imperial flour, finest numbers.				Medium flour.		Fine Spelz flour.			Three varieties of wheat-flour.		
	1	2	3	4	1	2	1	2	3			
Vegetable fibrine	7.95	71.55	69.40	70.48	81.61	78.62	70.22	71.14	71.90	71.29	70.73	71.20
Vegetable gelatine	14.40	16.00	17.57	16.92	7.54	8.35	16.53	15.36	17.20	19.56	13.64	15.43
Vegetable caseine	8.80	6.53	7.30	6.33	3.85	4.88	7.08	7.20	6.29	4.01	9.35	7.40
Oil	5.83	5.92	5.73	6.27	7.06	8.15	6.17	6.24	4.61	5.14	6.28	5.97

32. DEXTRINE, WOODY FIBER, CELLULOSE, STARCH, AND GLUCOSE.—The composition of starch, dextrine, woody fiber and cellular tissue shows the carbon, hydrogen and oxygen to be in the same equivalent proportions, and are given in the formula—

$$C_{12}\ H_{10}\ O_{10}$$

Glucose (fruit sugar) contains two atoms more of water, and has the formula—

$$C_{12}\ H_{12}\ O_{12}$$

This is the body into which starch and dextrine are converted by the action of ferment; and, by a kindred reaction, the glucose is converted into alcohol and carbonic acid, as given in the following equation:

$$\underset{\text{Glucose.}}{C_{12}\ H_{12}\ O_{12}} = 2\ \underset{\text{Alcohol.}}{(C_4\ H_6\ O_2)} + 2\ \underset{\text{Carbonic acid.}}{(C\ O_2)}$$

These changes, which play so important a part in giving porosity to bread by the yeast or leaven process, will be considered farther on.

33. That the phosphorus of wheat is present in the form of phosphoric acid, is evident from the experiments already mentioned, of treating the cross-section of wheat with ammonio-sulphate of copper, which yields a green substance, phosphate of copper, and flour with a solution of ammonio-nitrate of silver, yielding a yellow body, the tribasic phosphate of silver.

The circumstance that phosphoretted hydrogen is set free in the putrefactive fermentation of dough does not antagonize this conclusion, since superphosphate of lime composted with fermenting organic matter will yield the same product.

That the sulphur of the gluten and kindred bodies is in the form of sulphuric acid or sulphates, is exceedingly probable, though it is difficult to determine this point, because it is not easy to disengage the sulphuric acid without subjecting the flour to processes which involve the hazard of oxidation.

The circumstance that sulphuretted hydrogen is evolved in the process of putrefactive fermentation of moistened flour is not opposed to this conviction, since sulphates are readily reduced by liquid organic matter; as, for example, the action of ether upon sulphate of lime, which after a time yields the odor of sulphuretted hydrogen.

34. VARIETIES OF WHEAT.—The genus *Triticum* includes two species, *T. vulgare* and *T. spelta* and a vast number of varieties. These varieties differ from each other, whether bearded or not, whether single-headed or many-headed, whether having white or red chaff, and whether of white or red berry, or bluish; they differ in their period of ripening, in susceptibility to climatic influences, and in yield.

The general structure of the grain, physically considered, varies somewhat; and the composition as revealed by proximate and ultimate analysis also varies. There is a plump and a slightly shrunken berry; a brittle and a tough berry; a berry containing more lime and magnesia and one containing less of these ingredients; a berry in which the soda which is usually present in small quantity is very greatly increased

The gluten, the starch, the several nitrogenous substances, and the phosphates vary in proportion to each other and to the whole.

35. There is one quality in which samples of wheat differ very greatly from each other. It is in the products yielded by the grain when subjected to pressure or a blow, as in the process of converting it into flour. In this, the grains of different districts and of the same district in different years vary greatly. The Hungarian varieties selected for the production of the choicest flour and bread at Vienna were distinguished in these latter peculiarities. They yielded a more *gritty* flour.

36. HUNGARIAN WHEAT.—It would be perhaps difficult to determine to what special agency the marked superiority of the Hungarian wheat, or perhaps it should be said of the Hungarian flour, is to be ascribed; but, aside from the constant care of the farmer in changing the varieties grown, with the slightest deterioration in quality of the products, it is believed to be due largely to the *dryness and clearness of the atmosphere of the region in which the wheat is grown, at the time when the contents of the berry are in the condition technically known as "milk."*

37. "The climate of the Hungarian lower lands is marked by frequent and extreme vicissitudes. It is a continental climate. The modifying influence of the sea is not appreciable." As a consequence of the dryness of the air, notwithstanding the tolerably cool nights, there is no dew in summer. Soon after sunrise, the temperature rises to 74°–77° Fahrenheit, and in the course of the day attains from 95° to 100°, and there remains until nearly sunset. Not infrequently, the rain-storms, commencing in violence, pass over to a mild continuous rain, which seldom lasts more than two days, and produces an astonishing development of vegetation.

The driest months are July and August. Taking the average yearly moisture in the air in the mountain-lands at 81°.5, (maximum 100°,) in the west and southwest portions of Hungary it is 76°.5 and in the plains 71°, that is 8° lower than prevails in the North German plains.

The total annual rain-fall in all Hungary is 24 inches, distributed through 107 days. In the plains, it sinks to 19 inches, and this falls in 96 days.

The average mean annual temperature of Pesth is 51°.88.* The Hungarian summer is uniformly very dry.

38. How is this dryness to increase the percentage of nitrogen? The explanation would seem to be found in the more rapid evaporation of water from the leaves, which brings up the water from the soil and with it whatever is held in solution.

It would be expected that the inorganic constituents which are in solution in the water should be in augmented percentage; and this has been found to be the case. Mayer found the phosphoric acid to increase with the nitrogen, and believed the production of nitrogenous bodies depend-

* From the "*Skizze der Landeskunde Ungarns,*" prepared as an introduction to the catalogues of the Hungarian department at the Vienna Exposition.

ent on the presence of the phosphates. He found the ratio of phosphoric acid to wheat in the dried kernels to be as 1.078 : 2.20, or 100 parts of phosphoric acid to 204 parts of nitrogen. Ritthausen found the proportion of nitrogen somewhat higher, 100 of phosphoric acid to 258 of nitrogen.

39. The effect of the Hungarian climate on the development of the white wheat of Australia brought into Hungary and cultivated there, is seen on comparing sections of the original Victoria wheat with the product of the same grain after some time growing in Hungary in several particulars: 1. The kernels, which were originally white, have changed more or less perfectly to red; 2. In some, the portions most remote from the outer shell are still white or clouded; 3. In others, the whole of the kernel on one side of the groove is red, and a patch of the other from the surface inward remains white; 4. On shaving thin slices from a transverse section of such a kernel, the white part is found to be relatively tenacious, while the red is brittle; 5. In thin slices, the red portion appears quite as white as the white portion. It is perhaps safe to say that the Hungarian red berries are, as a general rule, more shriveled, more angular, or less rounded, than the white kernels of Victoria. They certainly are more shriveled than the samples of what is known as plump wheat in the United States.

40. Relation of climate to the percentage of nitrogen.—Laskowsky investigated a large number of Russian varieties of wheat collected at the great Russian Agricultural Exposition in 1864, determining their percentages of water, nitrogen, and oil. He found that, as compared with the wheat of other countries, especially those to the west of Russia and nearer to the sea, the Russian wheat was richer in nitrogen. The climate of Russia in the same latitudes was colder in winter, and warmer and drier in summer. The farther east one goes, the warmer does he find the summer, and the less the rain-fall. If this be the cause of the greater percentage of nitrogen, it ought to be found that, as one recedes from the sea coast, the percentage of nitrogen in the wheat should increase; and, as a matter of fact, this is the case, as the following table, taken from Kerl & Stohlman's Technische Chemie, will show:

	Percentage of nitrogen.
Scotland, (v. Bibra)	2.01
North and Middle France, (Reisch)	2.08
Neighborhood of Lille, (Millon)	2.18
Chemnitz, Saxony, (Siegert)	2.42
Bavaria, (Mayer)	2.20
Eldena, Baltic Sea, (v. Bibra)	2.18
Raitz Blansko, Mähren, (Gohren)	2.36
Poland, (Peligot)	2.68
Odessa, (Millon)	3.12
Toganrog, (Peligot)	2.54
Rjasan, (v. Bibra)	2.47

	Percentage of nitrogen.
Samaria, (v. Bibra)	3.47
European Russia, (Laskowsky)	3.58
Government of Wilna	1.95
Eriwan, (between Caspian and Black Seas)	4.30
Central Russian governments	3.57
South and Southeast Russian governments	3.72
Siberia, (v. Bibra)	2.65
Tobolsk, (Laskowsky)	2.74

41. To what the redness of red wheat is due may be seen under the microscope.

The hyaline coat—the testa—immediately within the cigar-coat, like the *rete mucosum*, is the seat of the pigment. In unripe grain, it may be seen to contain fine yellowish or brownish-red granules. Where both are wanting, and the interior is mealy, the berry is white. Where the granules are yellowish, the berry corresponds in color. Where the berry is red, the granules of the testa are red.

It has been stated to me by an experienced miller that in some samples of wheat the red matter of the interior of the groove is so abundant that it is quite impossible to obtain from them a white flour. It is spoken of by some millers as having a gummy consistency. I have carefully compared a very large number of analyses, organic and inorganic, proximate and absolute, to see if there exists any constant quantitative inorganic concomitant of the redness or whiteness of wheat. It is probably, purely organic. Mr. Thomas J. Hand, in his paper on "Wheat: its Worth and Waste," states that in the fully ripe wheat he examined, the cell-structure of the coloring matter was no longer defined. The coat was too delicate and filmy to be justly represented in a sectional view.

What agency determines whether a wheat-berry shall be red or white—that is, whether the color-coat shall be red or otherwise—is not clear. It is unquestionably a quality in part due to the original variety, and in part to conditions of growth at particular stages of progress toward maturity.

42. The berry from which the best Hungarian flour is made, is for the most part, of reddish color, is slightly shrunken, and cuts with a sharp knife throughout the cross-section something like the rind of old cheese. Under a sharp blow, it cracks into lumps. It reminds one of our best so-called southern wheat.

The plump, full berry, so abundant in the collections of the Northern Pacific Railroad, from the valleys of the Saskatchewan, in the American department of the Exposition, when laid open with the knife, presents a relatively less flinty or hard interior; the investing coats only of the wheat presenting any considerable obstruction to the edge of the blade. Under a sharp blow it readily falls to powder. It is uniformly larger than the Hungarian berry.

43. Through the kindness of Graf Heinrich Zichy, of Oedenburg, Hungary, president of the international food-jury, and under the immediate

superintendence of Herr Dosswald, director of the Pesth *Walzenmühle*, a collection of all the choice varieties of wheat grown in Hungary, and of those grown with success in some other countries and introduced into Hungary, has been supplied to aid in this investigation. The list includes in all 42 samples.

44. VARIETIES OF WHEAT WHICH ARE PRODUCED IN HUNGARY.—

GROUP I.

1. Békés improved Hungarian wheat.
2. Scönyer Hungarian wheat from poorly-tilled soil.
3. Scönyer Australian wheat from well-tilled soil.
4. Tolnan wheat.
5. Temeser Comitat Hódoser wheat grown in stubble-field.
6. Banat Hódoser wheat grown after corn.
7. Banat Hódoser wheat grown in fallow field.
8. Erczier wheat.
9. Erczier wheat of 1874.
10. Autumn-wheat from Upper Hungary south of the Danube.
11. English wheat from the Banat.
12. Neograde wheat.
13. Theis wheat.
14. Theis wheat improved.
15. Veszpremer Comitat Adelaide wheat.
16. Veszpremer Comitat Theis wheat.
17. Australian Victoria wheat, Borsodor Comitat, 1873.
18. Victoria wheat, 1874.

GROUP II.

19. Summer or winter wheat with white heads.
20. Improved Caucasian wheat.
21. Triticum amylon album.
22. Triticum compactum nudum rubrum.
23. Triticum vulgare nudum.
24. Triticum vulgare Littorale Hungaricum.
25. Triticum vulgare nigro aristatum Banatense.
26. Blè Mars. Triticum nudum æstivum.
27. Triticum album densum.
28. Triticum turgidum spica, aristis violaceis.
29. Triticum Hungaricum rubrum nudum.
30. Triticum vulgare aristatum rubrum.
31. Triticum durum aristatum rubrum.
32. Triticum vulgare albo aristatum.

GROUP III.

33. Neograde wheat.
34. Theis wheat.

35. Yellow Banat wheat, Lower Banat.
36. Red Banat wheat, Banat.
37. Weissenburg wheat.
38. Pest-soil wheat.
39. Wheat from the Upper Hungary plateau.
40. Original Adelaide wheat.
41. Hungarian wheat from Australian seed.
42. Slovak wheat.

Extract from the report transmitted by Graf Zichy.—"In the first place, winter and summer wheat succeed. Both may be bearded or bald; all are cultivated.

"Some varieties have short berries, and others are long with corresponding diameters.

"The color is sometimes dark and sometimes light. The dark color is found among all native varieties; the light is found in all imported varieties.

"As a general thing, Banat wheat is sown. In all parts of the kingdom, occasionally, changes in the seed yielding other formed and colored berries of Banat wheat appear, as a consequence solely of degeneration.

"Besides the Banat wheat, in recent times there have been sown Australian and Victoria wheat with some success."

45. "Here follow the results of harvesting and grinding of samples of these two kinds:

"FIELD-PRODUCTION.

"Banat wheat, 19 metzen* per 1,600 □°.†

"Australian (Adelaide) wheat, 25 metzen per 1,600 □°.

"MILLING-RESULTS.

"*Banat wheat.*

	Per cent.	
"Flour, No. 0–2	14.1	19.4
"Flour, No. 3	5.3	
"Flour, No. 4	8.2	24.7
"Flour, No. 5	16.5	
"Flour, No. 6	13.2	21.4
"Flour, No. 7	8.2	
"Flour, No. 8	7.6	
"Bran, No. 9	17.6	
"Bran, No. 10	3.0	
"Waste, No. 11	2.3	
"Loss	4.0	
	100.0	

* Metzen = 16 wine-gallons. †□° = unit of land-measure.

"*Australian wheat.*

	Per cent.	
"Flour, No. 0*	4.7	23.8
"Flour, No. 3	19.1	
"Flour, No. 5	24.0	
"Flour, No. 6	27.3	
"Flour, No. 8	2.5	
"Bran, No. 9	12.0	
"Bran, No. 10	6.0	
"Loss	4.4	
	100.0	

"GLUTEN, (MOIST.)

"*Banat wheat.*

	Per cent.
"No. 0	.36
"No. 3	.37
"No. 5	.38
"No. 6	.46
"No. 8	.26

"*Australian wheat.*

	Per cent.
"No. 0	.32
"No. 3	.35
"No. 5	.45
"No. 6	.40
"No. 8	.47

"The experiments of the bakery show the superiority of the Hungarian wheat. On the whole, the Australian wheat soon degenerates and becomes inferior to the Banat wheat.

"Altenburg, Hungary.

"GRAF RENNER."

46. The varieties of wheat recognized in the botanical gardens and agricultural institutions of the different states of Europe are numerous. Before me is a list of forty varieties prepared in Saxony. The number produced at Hohenheim, in Würtemberg, is large. Most of these, and doubtless many others, were on exhibition at the Exposition, in many instances exquisitely arranged.

In the pavilion of Prince Schwarzenberg, effect was added to the display by arranging the different varieties in contiguous variously-shaped cells constituting a mosaic, in which the different shades of color and the varieties in form were brought into contrast. The collections of the different states of the German empire were most extensive, as were also those of the Austro-Hungarian empire, and indeed of most of the countries represented at the Exposition.

The collection sent by the direction of the Northern Pacific Railroad was of great excellence, variety, and extent, and received the medal of *merit*.

47. STRUCTURE OF THE WHEAT-PLANT.—In the agricultural collections of Germany and Austria particularly, there were most carefully

*The terminology of the Hungarian milling-system—the meaning of the numbers—will be presented under the subject of milling.

prepared specimens illustrating the structure of the whole plant; its growth, and especially the influence of the condition of the subsoil upon the development of the fibers of the roots. These were presented in their whole length and utmost detail, exhibiting in some instances an extension from the surface of the soil downward exceeding a full yard.

The specimens prepared by Baron Horsky, of Horskysfeld, near Kolin in Bohemia, attracted special attention, as showing how far, where the soil is penetrable, the roots will extend to reach water or needed nutriment.

48. THE PRESERVATION OF WHEAT IN LARGE MASSES AGAINST HEATING.—The excellence of the Vienna bread is not due to any single peculiarity in the processes pursued by the Vienna baker, but is to be ascribed to the fidelity with which the susceptibilities of the grain are respected and observed in all the changes to which it is subjected, from the time the seed-wheat is selected and sown, through all the career of growth and ripening, the harvesting and the threshing, transportation, keeping in the granary, and milling, to the time when the selected portions are subjected to the processes of the baker resulting in bread.

The moist atmosphere which characterizes the English climate, and so frequently interferes with the harvesting there, and not infrequently does great injury to the crops in some sections of our own country, both before and after the grain is cut, and previous to its being stacked or housed or threshed, is unknown in Hungary. Great care is taken, in the erection of the shocks in the field, to allow any rain that may fall to run readily off or speedily to dry away. Few things impress the traveler, in passing through the Austrian empire at the conclusion of the wheat-harvest, with more grateful surprise than the carefully constructed and capped shocks of moderate uniform size and almost military regularity of arrangement, in which the wheat remains in the field to become thoroughly dried, preparatory to the gathering into stacks or barns to be threshed.

49. In threshing the grain, the flail is still extensively used in various parts of Austro-Hungary.

Care is taken, when the grain has been threshed, cleaned, and prepared for market, and when the quantity is small and not thoroughly dry, by occasional turning over with the shovel, to expose all parts of it repeatedly to the air, and so prevent "heating," and to destroy any microscopic vegetation or mold, the spores of which are ready to take advantage of the moist surface of the berry and work the deterioration of its contents.

50. On the estate of Baron Horsky in Bohemia, which was exhibited to the food-jury, was a so-called American granary, provided with an elevator for the purpose of carrying the grain to the uppermost of a series of perforated floors or shelves, by means of which the grain could be made to fall in numerous slender streams through successive air-

spaces to the hopper at the bottom, from which the grain was again carried in the buckets of the elevator to be discharged on the upper shelf, and so made to go round and round until the desired dryness had been obtained. This is only one of the numerous devices which this prince of agriculturists has introduced for the scientific solution of the problem of producing a perfect wheat-berry. An apparatus for this purpose, to be used also as a malt-kiln and malt-sprouter, by Joseph Geeman, of New York, exhibited in the American department of the Exposition, received the distinction of honorable mention.

51. DISEASES AND ENEMIES OF THE WHEAT.—Among the most interesting of the exhibitions of material for illustration in the department of technical education, from Bohemia, Hungary, Austria, and the German empire, were elaborate preparations of the various insect-enemies, presenting their habits, the development of their eggs in all stages of their growth, and the modes by which the injuries effected by them are accomplished.

It is to be regretted that it is quite impossible to give any description commensurate with the merit of this department of the Exhibition, as in many cases they existed only in the particular samples submitted at the Exposition, and were accompanied by no special description.

These results of the labors of love on the part of teachers and of institutions for instruction in technical education were eminently suggestive to any one interested in object-teaching, and showed how possible it is to bring within the sphere of thorough scientific investigation the minutest conditions upon which the success of the practical agriculturist depends.

Wheat-blight, rust, ergot, honey-dew, Hessian fly, and the red, black, and white weevil are familiar names; but how much more would they signify to us with scientifically-arranged actual specimens, displaying the results of anatomical dissection and microscopic analysis, illustrating every stage of their growth and their habits, the parts of plants in which the eggs and spores are deposited, and the kind and extent of injury which they produce!

52. IMPURITIES IN WHEAT.—Commercial wheat is rarely absolutely pure. Beside the dust and sand, chaff and straw, there are numerous seeds which more or less find their way through the fanning-mill to the granary, and require to be separated from the wheat-berry before the wheat is fit for grinding. Among these may be mentioned numerous varieties of wild onions, vetches, pease, parsley, beans, radishes, mustard, chess, oats, grass-seed, cockle, fragments of straw and chaff, &c. All these, together with blasted kernels of wheat, rust, and ergot, (smut,) must be effectually removed.

It is plain that shriveled or blasted berries in the process of milling would, for the most part, be resolved into fine bran, and so be with difficulty separated from the flour, and thus the flour discolored and rendered less nutritious.

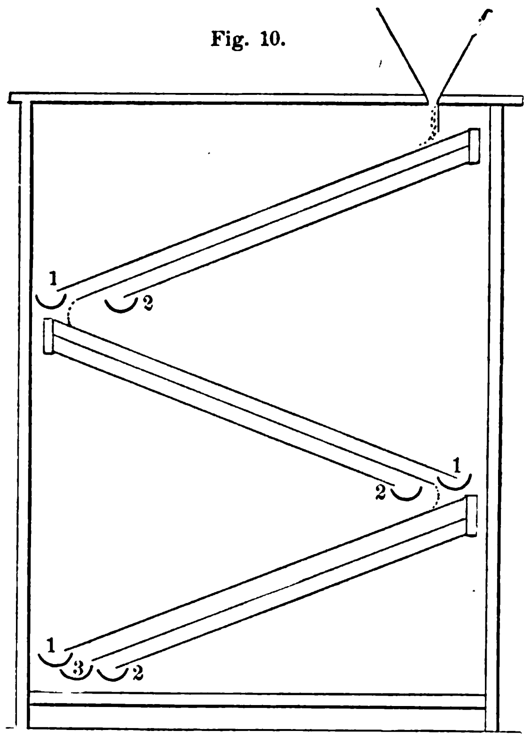
Some of the foreign seeds impart unpleasant taste; some are not wholesome for food; and most of them impair the color of the flour.

53. Various mechanical devices are in use for separating the light grains from the heavy, and the foreign seeds, grains, and other impurities from the sound wheat. The sieve is one; another is the blower, causing a current of air to act upon a thin cascade of falling grain.

In the sifting process, advantage is taken of the unequal size and of the different shapes of the bodies to be separated from each other. It is easy to see how light grains and chaff, bits of straw and fine dust, would be farther diverted from a perpendicular in falling through a current of air driven by a revolving fan than the heavy sound grain. This principle was illustrated in the earliest times when the mixed wheat and chaff were tossed together into the air to be separated by the wind before reaching the ground, and is the principle underlying the ordinary fanning-mill.

The separation of mustard, cockle, and grass seed from the wheat may be easily effected by passing the mixed grains over inclined plates perforated with holes large enough for the smaller seeds to pass through but not large enough for the wheat.

Fig. 10.



Sketch of side view of Jewell's separator.

1, oats, chaff, &c.
2, mustard, cockle, grass-seeds, &c.
3, sound wheat.

54. The oat-grain is separated by taking advantage of its elongated form. The mixed oat and wheat grains are discharged in a thin sheet upon an inclined jogging, thin iron plate, perforated with round holes, at intervals nicely determined by experiment, abundantly large for the ready passage of both the wheat and oat grains if presented end foremost perpendicularly to the surface of the plate. But as the plate is inclined, each berry must be tipped forward in order to enter a hole. An individual hole is of such diameter that when the wheat-grain sliding forward carries its center of gravity beyond the support of the upper edge of the hole, there will be room for the prow, that is, the forward end of the grain, to sweep downward through the hole without striking its lower margin, and thus the wheat-grain be separated. The oat-grain, however, in sliding down the inclined plane, before the center of gravity has passed beyond the support of the upper margin of the hole,

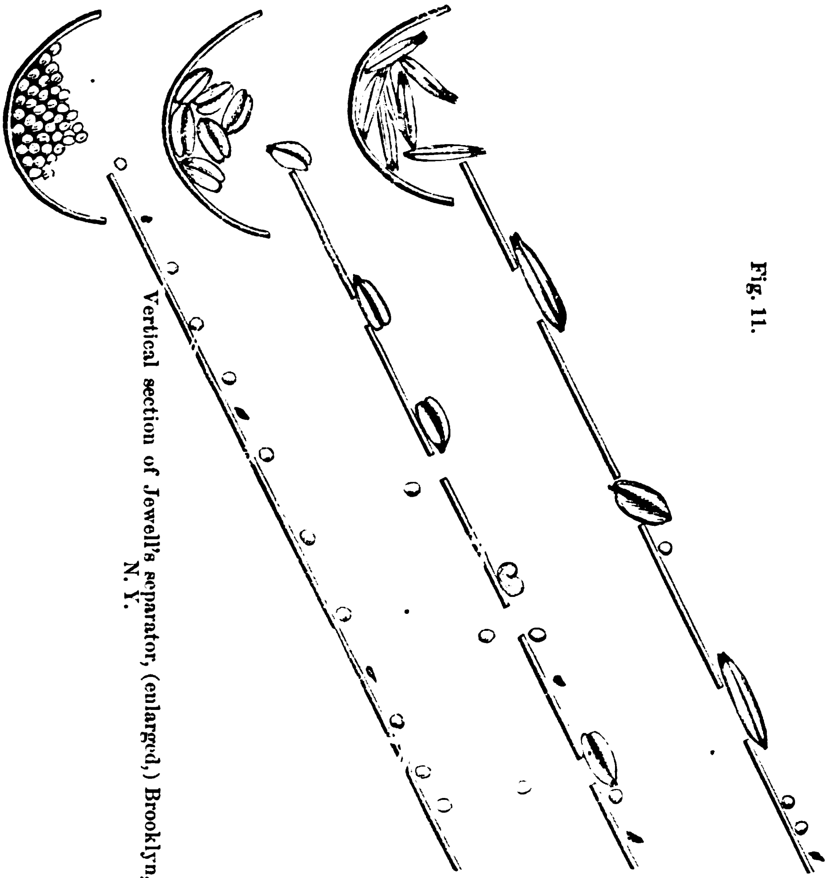


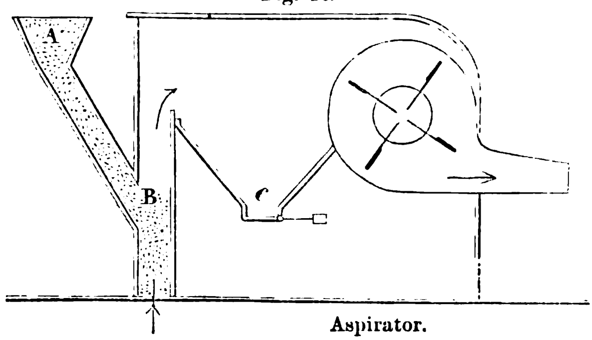
Fig. 11.

Vertical section of Jewell's separator, (enlarged,) Brooklyn, N. Y.

will, by reason of its prolonged hull, extend over the lower margin of the hole, and thus fail to fall through. As the oat-grain advances, the center of gravity will pass beyond the lower edge of the hole and gain the support of the continuous surface before the tail of the berry will

have lost the support of the upper edge. The accompanying cuts (Figs. 10 and 11) illustrate without further explanation the process by which the

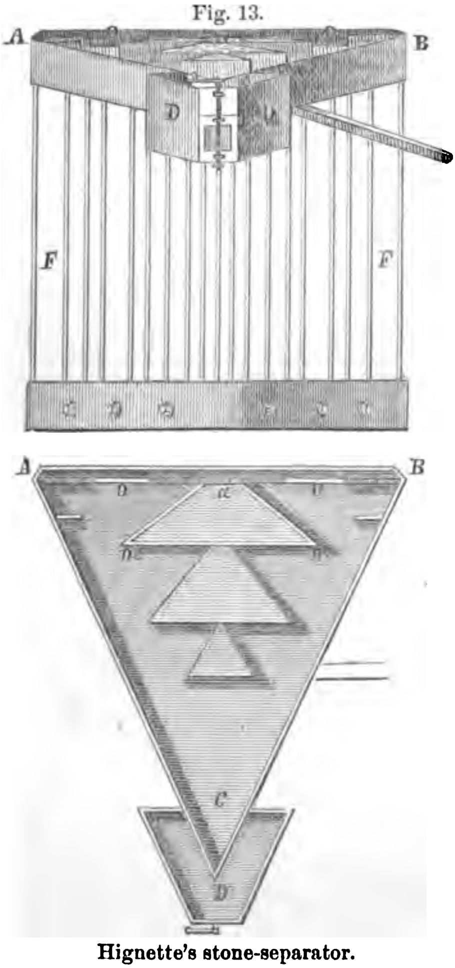
Fig. 12.



Aspirator.

oat-grains are separated from the wheat. Fragments of straw and chaff will pass on with the oat; while mustard and other seeds smaller than the wheat are separated by a second screen.

Fig. 13.



Hignette's stone-separator.

55. For the separation of the heavy or sound from the light or blasted kernels and from straw or chaff, the apparatus shown in Fig. 12, and called an aspirator, is employed. The wheat enters at A. The current of air enters through the falling grain at B, drawn by the exhaust-fan. The heavier kernels drop directly down. The lighter and blasted kernels fall to C, and the lighter chaff and straw pass out through the exhaust-chamber.

This apparatus was on exhibition as Bauer's patent exhaust-purifier or aspirator.

To separate the heavy from the light grains, and also to separate coarse sand or minute pebbles from wheat, the machine shown in Fig. 13, and known as J. Hignette's stone-separator, was on exhibition.

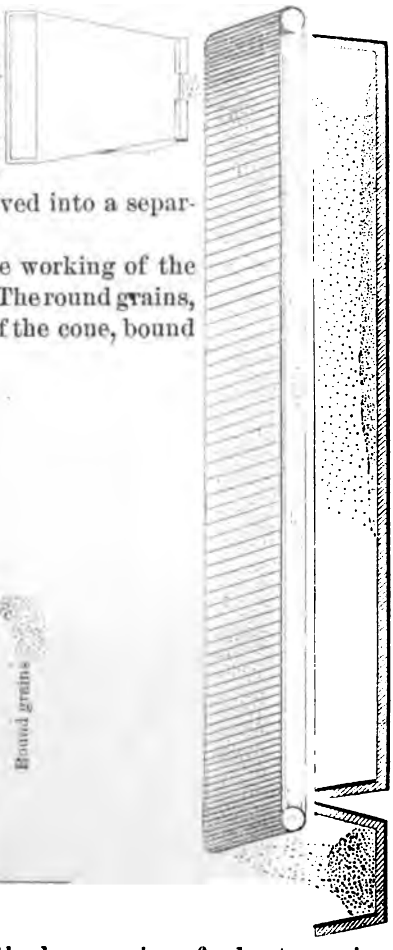
The grain enters at A from a spout, upon a slightly inclined surface, resting on slender wooden supports. As a consequence of a peculiar jarring or shaking, the

heavier particles or grains work toward the angle C, where they drop into the compartment D, while the lighter escape over the low passes at *o o'*.

56. SEPARATING ROUND SEEDS.—Another device has been employed in the neighborhood of Vienna, in which advantage has been taken of the spherical form of certain of the foreign seeds to effect their removal.

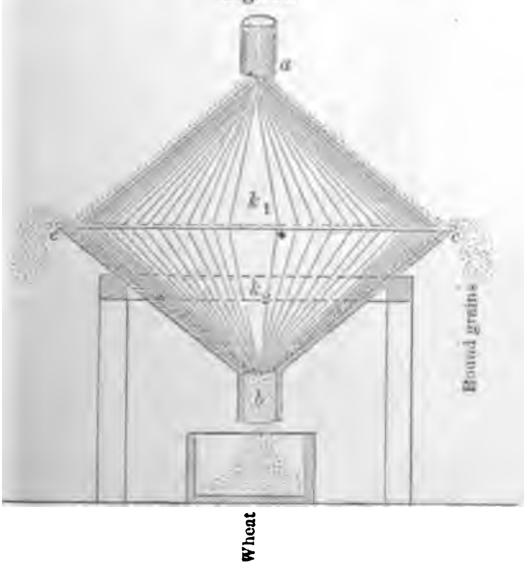
The wheat, with its mingled mustard-seed, wild pease, and other round grains, is discharged through a tube upon the apex of a varnished wooden cone, the slopes of which are inclined to the perpendicular at an angle of about 55°. The elongated wheat-grains slide to the bottom within a certain time, being retarded by friction. The round grains, however, rolling down the side of the cone, acquire very much greater velocity, and leap across a narrow opening at the base of the cone; while the wheat-grains, moving much more slowly, fall into the opening, and are received into a separate receptacle.

Fig. 15.



The following figure (14) exhibits the working of the apparatus. The spout *a* is adjustable. The round grains, striking the slender ledge at the base of the cone, bound

Fig. 14.



or leap across the openings *c c*, while the long grains of wheat, moving at a slower rate, fall through and descend the incline to *b*.

57. Still another device in use in the steam-mills of best repute in Austria may be mentioned. An endless apron, stretched upon two equally-inclined cylinders, receives the grain in a thin stream. The inclination is such that, as the apron moves along, the spherical grains

roll off from the lower edge of the apron, while the wheat-grains, incapable of rolling, are discharged from the apron at the curve of the cylinder.

The accompanying diagram (Fig. 15) will illustrate the construction and action of this device.

58. Another device is shown in the following diagrams, (Figs. 16, 17;) it is known as Vachon's separator. It consists of a cylinder, partly of perforated plate or wire-cloth screen and partly of peculiarly roughened surface not perforated, within which is a trough. The first part of

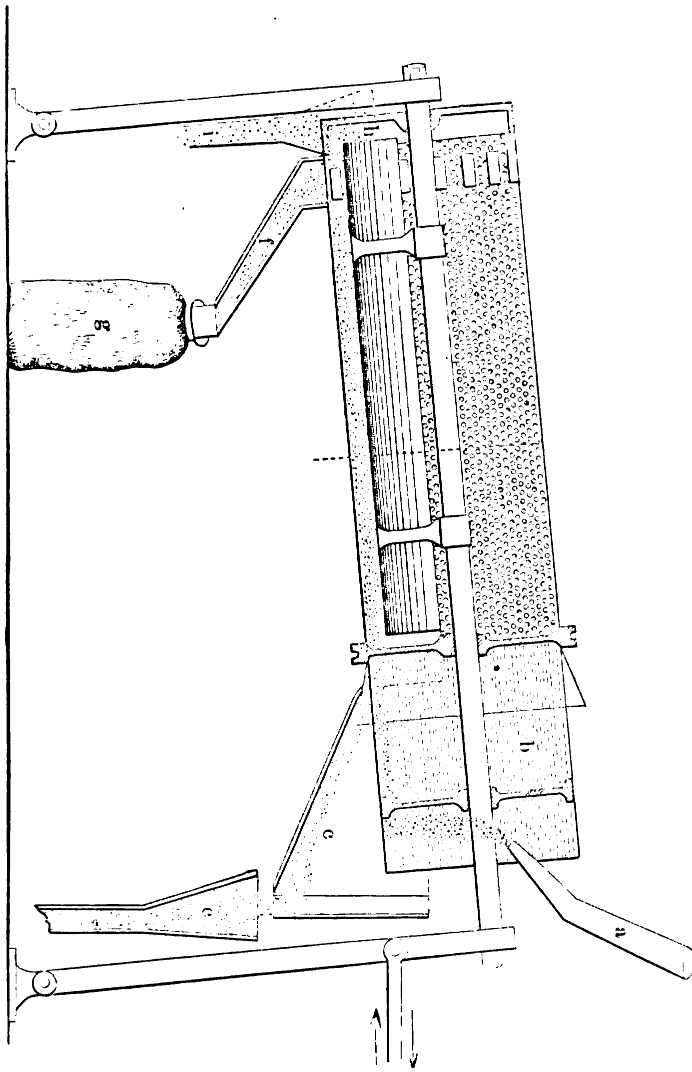


Fig. 16.

the cylinder consists of a perforated plate of such construction that only seeds smaller than the sound wheat-kernels can pass through. The remainder of the cylinder is not perforated, but is covered with a pitted

surface as shown in Fig. 17. The cylinder sits loose on the axle, and is kept in slow revolution. Within the cylinder is a trough made fast to the axle, concentric with the outer cylinder, shown in Fig. 16. The cylinder has beside its slow rotation a shaking motion, and is inclined at an angle of about 10°. By means of this motion, the wheat comes at length to the end of the cylinder. It does not rise high enough on the side of the cylinder to fall into the trough, being shaken out, while the round pease and other seeds like them are carried higher, and reach the

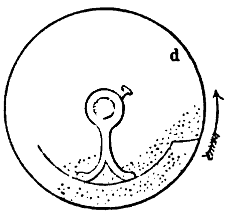
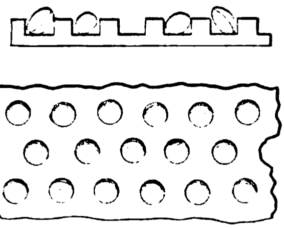


Fig. 17.



trough as they fall, and are at last discharged at *h i*. The wheat-grains reach the bag *g*; the finer particles have already been left in *c*. It is easy to see that while this machine may work well, as it is said to do, its yield must be small.

By these and kindred devices, and by graduated currents of air separating the shrunken or blasted kernels, the sound wheat-grain is effectually purified from all foreign substances.

59. The numerous devices on exhibition at Vienna for the purification of the grain as harvested, preparatory to the first step in milling, may all be regarded as more or less complex mechanical contrivances for the application of one or more of the principles that have been explained above.

Wheat will not "pass muster" at the Corn Exchange in Vienna when it has a musty smell, is warm, has suffered from weevil or has been worm-eaten, is blasted or is not sufficiently cleaned, or which contains more than from 3 to 5 per cent. of foreign seeds, which is to be determined by careful counting of the grains of a quarter of a pound.

60. Removing smut and dirt.—Washing the grain has been resorted to in the absence of facilities for removing the smut and dirt by mechanical appliances. It is true that the wheat is made by this process to look much brighter, and when the surface only is dried the grain is necessarily heavier from the absorption of water. But the absorption of water, if the wheat or the flour produced from it is to be kept any considerable length of time, is injurious from its facilitating the growth of mold and the introduction of those chemical changes which result in "heating," the disintegration of the gluten, and the general deterioration of the flour.

For drying wheat that has been washed, the apparatus of Joseph Geeman, of New York, already mentioned, which consists of a series of troughs supported in a column of heated air, with an automatic arrangement for filling and emptying, seems well suited.

61. The unbranning of wheat and the removal of the beard.—By the mere rubbing of wheat-grains between brushes, it is not practicable to effect the complete removal of dirt and smut. Allusion has already been made to a process by which the dirt and smut together with the beard and the two outer coats of bran may be removed, with the exception of the portion contained in the bottom of the longitudinal groove on one side of the berry. This process, which may be illustrated on a small scale by rubbing a handful of moistened grains in the folds of a coarse towel, has been successfully carried out upon a large scale by a device invented by Samuel Bentz, of the United States.

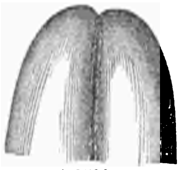


Fig. 18.

The appearance of a berry from which the outer true bran has been removed down to the gluten-coat, except the portion within the groove, by the process of Mr. Bentz, is shown in the above figure, (18.)

The accompanying diagram (Fig. 19) will show the appearance of a transverse section of wheat at the instant of unbranning, with portions of the vegetable hairs and a part of the cigar-coat wholly detached.

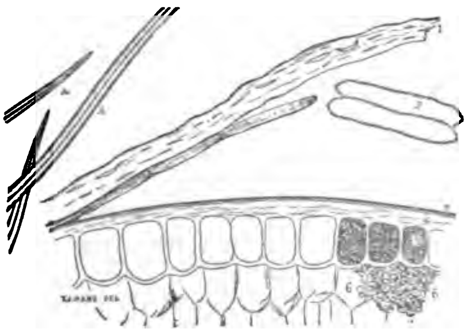


Fig. 19.—Portion of transverse section of unbranned wheat, 150 diameters.

1, 2, true bran, not yet detached at one extremity, 150 diameters.

2, detached cells of inner true bran, "cigar-coat," presenting their sides, 150 diameters.

A, A, portions of hairs from the *brush*, 100 diameters.

The annexed diagram, (Fig. 20,) like the former, from the pencil of Mr. Hand, shows the impossibility of perfectly unbranning the berry. The portion of the bran within the groove is mechanically sheltered from any effort of friction.

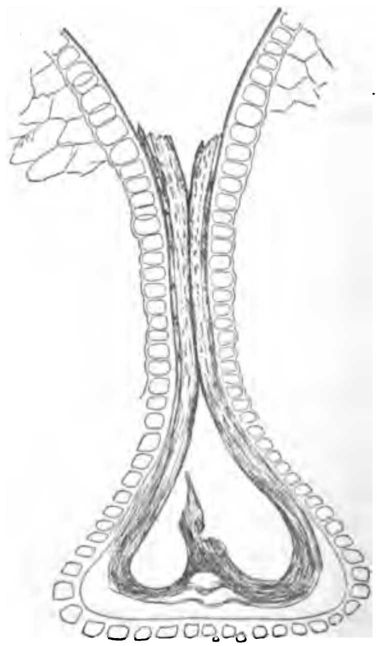


Fig. 20.—Transverse section of the *crease* of a kernel of unbranned wheat, 60 diameters. Gluten-cells in outline only.

62. Smut-machines.—Numerous devices of so-called smut-machines have been invented, in which the outer coat is more or less removed, and with it the brush, or beard. These rest in the main upon the principle of passing the wheat between sharply roughened or pointed iron sur-

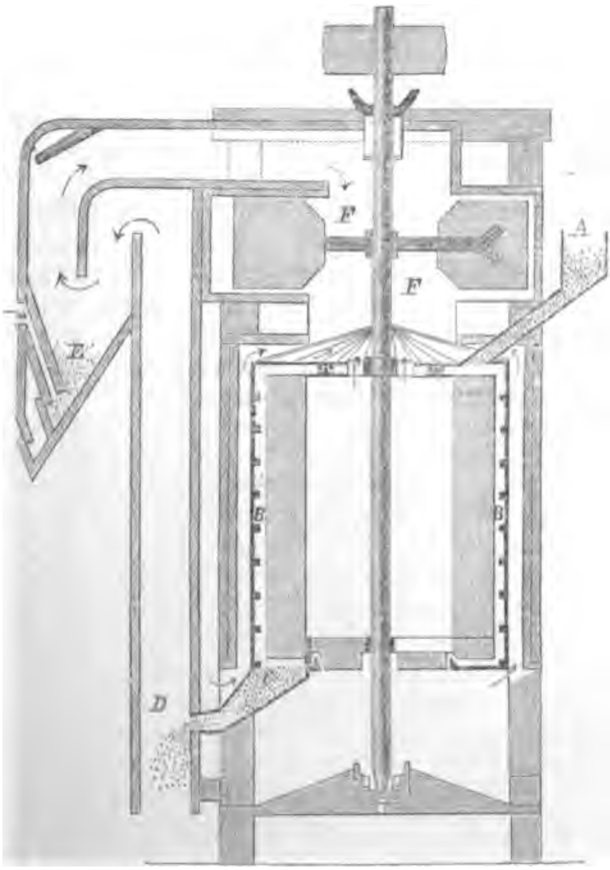
faces, as teeth or wire brush, or beaters upon the surface of a cylinder, or frustum of a cone, revolving at a high speed within a metallic case perforated with holes or slits, serving the double purpose of permitting the dust to escape and presenting a rough surface.

In all this department of cleaning the grain, there was a great variety of devices on exhibition at Vienna, the detailed description of which does not properly belong to this report.

The clipping of the brush and the germ at the opposite end is also effected by passing the grain between millstones, separated from each other by a distance a little less than the length of the grain and beard together. It is obvious that, in its passage between such stones, the grains will be abraded only when in position vertical to the surface of the stones.

The wheat grading and purifying machine of Howes, Babcock & Co., Silver Creek, N. Y., received the distinction of the medal of progress It is presented in section in the accompanying drawing, (Fig. 21.)

Fig. 21.



Howes, Babcock & Co.'s machine for removing smut, pointing, and cleaning grain.

The wheat enters at A, passes through the cylinder B B, comes through C to D, where it encounters the current of air produced by the exhaust-fan, which conducts the light kernels to E, the bran to F, and the fan-chamber which leads to the dust and bran chamber. The air moves in the direction indicated by the arrows. The particles of dust, hairs, smut, &c., that pass through the walls of the cylinder B B, are carried by the exhaust to F. The excellence of the work of this machine is indorsed by Professor Kick in his official report to the Austrian government.

63. SCOURER.—Following the smut-machine, there has been introduced in some mills a *scourer*, consisting of a stiff brush, against which and below, a grooved burr-stone is made to revolve, between which the wheat passes. It serves to remove still adhering hairs and loosened portions of the outer bran, and presents, after passing through a blower, a berry of remarkable smoothness and look of purity. By this process, some varieties of wheat lose, beside the hair, portions of the outer layer of true bran, traces of the cigar-coat, and scales from the surface of the embryo.

To effect the same end in other mills, the wheat is passed between a grooved steel cylinder and a segment of a stone shell, in which the abrasion of the surface of the wheat and the partial removal of the outer bran-coat are produced. Others present a cylindrical grater operating against a surface of stone.

64. The importance of the proper conduct of the process of milling will be apparent from a simple statement found in the records of the Pesth milling.

Hungarian flour has been sent from Pesth to Trieste, and thence by sea to San Francisco and back to Trieste and Pesth, crossing the equator four times, and yet on its return found to be just as fresh, sweet, and free from anything like sour or musty smell as when it was first received from the bolt at Pesth.

To arrive at a just conception of how such flour was produced will justify the most detailed discussion of the subject.

CHAPTER II.

THE ART OF MILLING.

65. In its earliest history, the pulverization of wheat was effected by successive blows and rubbing, as in a mortar. This process involved the two effects upon the grain of varying pressure and impact. If a grain of hard wheat be subjected to pressure, as in a vise, so that its diameter shall be lessened by a certain definite amount, the interior may be partially pulverized without rupturing the surface. If the pressure reducing its diameter by the same amount be of the nature of impact or of a blow, the interior will be cracked but not pulverized, with the probable rupture of the surface. If the pressure of the vise be continued until the grain is flattened, the product will be large scales and powder. If the grain be subjected to repeated blows, sharp enough to crack but not severe enough or prolonged enough to crush, the product will be a series of fragments of various sizes, some of them having bran-scales attached.

66. Down to the beginning of this century, the construction of flouring-mills was exceedingly simple. There were a single pair of millstones and a single bolt, of which the motive power might be water or wind, horses or cattle. Everything else must be accomplished by manual labor, and the conveniences consisted of some shovels, barrels or tubs, and sieves. The wheat was usually ground in a wet condition, as moisture increased the toughness of the bran and prevented it from being reduced to fineness, and so promoted the whiteness of the flour. In the early part of this century, the first decided improvements, which ultimately resulted in the process of high milling, were made in the neighborhood of Vienna. The history of it, as given by Roman Uhl, is condensed in the following paragraphs.

67. Origin of high milling.—The wheat was broken or cracked as finely as possible, and then the coarser parts were separated by agitating in tubs or boxes having sieves across the bottom. The bran, working to the surface because of its lightness, was from time to time separated by means of a little shovel, leaving at the bottom coarser fragments consisting of gluten, with more or less of the adhering outer coats of the bran on the one side and on the other of the interior of the berry. This material was assorted by means of sieves operated by hand, and constituted, according to Roman Uhl, the article of commerce known as Vienna grits, (Vienna *Gries.*)*

*Our synonyms are not perfectly suited to the case. Grits, farina, semolina, and pollard are used to distinguish the article produced. *Schrot* may be described by the roundabout phrase of broken or bruised kernels. *Unpurified grits* corresponds pretty

They were on sale in 1810 in Berlin under the same name, and were sent from the neighborhood of Wiener Neustadt (Vienna New City) to Trieste and Venice. The demand for these grits suggested the idea of coarser grinding, that is, grinding with the stones farther apart, and thus was the first step taken in the art of *grits-milling* or *high milling.*

Acts of the Austrian government in 1809 and 1810 giving freedom to the sale of flour and the erection of mills stimulated the development of milling in the neighborhood of Vienna to an unanticipated extent.

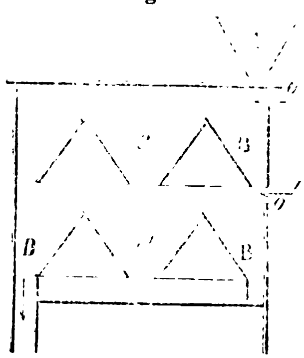
68. The recognized pioneer in invention in this direction was Ignaz Paur, born July 22, 1778, in Tattendorf, Lower Austria, died September 6, 1842, in Lichtenwörth, near Wiener Neustadt. He was first a miller in Vöslau, afterward in Schönau, and came in 1810 to Leobersdorf.

Paur made the experiment of grinding again the separated grits, and obtained a flour called from that time forward "*Auszug,*" or extract flour; and such was the demand for this flour that the utmost effort to produce by hand-sifting the needed grits was inadequate to meet it.

After various experiments, he constructed, in association with a cabinet-maker by the name of Winter, the first so-called cleaning or purifying machine, attached to the bolt, and at the same time the double grits-cleaner.

69. The principle of separating the grits from the bran by means of a current of air introduced through an opening into the machine is maintained to this day, and varies but little from the device invented by Paur.

Fig. 22.



Groats or grits purifier of Ignaz Pauer.

A is the hopper, from which the broken wheat-grains fall into the purifier. O is an opening, through which a current of air is driven upon the falling fragments; the heavier fall through the division B, the next heavier fall at C, and the lighter are blown over to D. What falls through B encounters another current of air from O′, which carries the lighter to C′, and the heavier portion of C falls into C′, while the lighter of C′ and the still lighter of B′ are carried over to D. Thus the fragments are resolved into three grades according to their susceptibility to be borne by the current of air.

The method of grits-milling or high milling was carried from Vienna to Hungary, Bohemia, Saxony, and elsewhere.

70. Difference between high and low milling.—The difference between high and low milling may be comprehensively stated to be this,

well with the word *middlings*. *Gries* is applied in German to the purified grits, and also to the mixture of purified grits and the bits of bran from which it has been separated in the process of purification. The terminology is at the best incomplete. I have tried to do the best I could by employing "groats" for *Schrot*, "middlings" for *Ueberschlag* or unpurified *Gries*, and "grits" for purified *Gries*.

that in high milling the wheat is reduced by a succession of crackings, or of slight and partial crushings, alternating with sifting and sorting the product, while in low milling the reduction is effected in a single crushing.

In the former, the grinding surfaces are at first remote, and are made to gradually approximate as the products become smaller. In the latter, the distance asunder of the grinding surfaces is fixed at the outset. The former may be so far separated as to merely clip the ends of the grains; they may be so near that a sheet of thick writing-paper would fill the whole space between them, and they may be separated from each other by distances anywhere between these extremes, and the products will vary accordingly.

In the high milling, the velocity of the running stone is low, while the reverse is generally true in low milling. Some varieties of wheat are better suited to the process of high milling, as the hard Hungarian wheat; others, as the softer winter or spring wheat, for example, are better suited to the process of low milling, which prevails generally in North Germany and the United States, and is believed to be more profitable to the miller, taking all the influencing circumstances into consideration, the demand for the choicer flour more especially, than high milling would be.

71. The jury on the products of milling at the Vienna Exposition took the ground that had been previously assumed at the Paris and other Expositions: that the products of high, half-high, and low milling should be judged, each class by itself, inasmuch as, already remarked, some kinds of wheat are better suited to one kind of milling and others to another.

72. HIGH MILLING, as explained by Kick in his comprehensive work, Leipsic, 1871, on "*Mehlfabrikation*," is substantially summarized as follows:

"The reduction of the wheat by the process of high milling is step by step, and the separation of the products is not alone according to the magnitude of the particles, but also according to their specific gravity.

"If one rubs grains of wheat gently between millstones, which at first are one-twelfth of an inch apart, then one-quarter less, and then one-half less, and so on, there is obtained successively a finer and finer product. By the first operation, which we will call clipping, or pointing, a part of the shell or outside coat, the brush, and more or less of the germ, will be removed, and there will be produced grains, from which already many little particles which should not appear in the flour have been separated. The outer bran and hulled kernels coming together from between the stones may be separated from each other by passing them through a cylindrical sieve. The hulled grains, by passing them next through the stones brought nearer together, yield a cracked wheat, a product consisting of various finer particles, which may be graded by sifting. The products obtained are called groats, (bruised or cracked fragments

with bran attached,) grits, (smaller fragments,) and finer particles, flour. The flour obtained consists for the most part of cells and particles from the outer portion of the grain, fragments of the bran, and of the gluten-coat, which make the flour dark. It is called *pollen.*"

The grits will consist also of a mixture of fragments of outer and inner parts, and bits of bran of the same size, which go through the sieve with the grits. A product corresponding with this somewhat, used to be called "*connell,*" and is now known as "*middlings.*"

73. The groats freed from the finer particles will be again ground, and this produces a second groats, grits, and flour; the second groats yield also groats, grits, and flour. Particles which are smaller than groats and larger than grits are called "solutions;" such as are between flour and grits are called "dust;" and these must obviously be produced by cracking. By each succeeding cracking, the flour and grits produced will consist more of particles from the *interior* of the kernel of wheat, and as the interior cells, that is, the starch-cells, yield a whiter product, so the flour and grits will become more and more fair and white; and this, until the groats after the fourth grinding will possess the form of disks, having only a thin layer of starch-cells. In flour, this phenomenon is very striking. The flour from the third groats is much fairer than that from the second or from the first groats; this is less striking in the grits, in that it is still largely mingled with particles of bran. The bran-particles are much lighter than the grits, and this property is taken advantage of to purify the grits by means of a current of air directed upon a thin sheet of falling grits. This work is accomplished by the grits-purifying machine, in which the air operates either by blast or suction.

74. In the gradual grinding and purification of the grits lies the essence of the high or grits milling. This can be effected by various modifications. The wheat may be three, four, or five times cracked or bruised; the grits, which have been separated according to their size, may be more or less purified; and finally the purified grits may be either rapidly or slowly ground to flour.

75. In the unpurified grits, which correspond more nearly with American *middlings*, there is not only bran, which falls with it through the sieve, but there is a part of the grits, namely, the coarser, consisting of such granules as contain broken fragments of the outer part of the grain, and as such have firmly attached portions of the hull.

These particles of the hull cannot be separated by the middlings-purifying machine; and, if this is to be done, such grits must be reduced to smaller particles by passing them through properly-adjusted stones.

From the product of milling thus obtained, the flour will be bolted, and the grits subjected to a further purification.

When the last traces of bran have been separated from the grits and the still finer dust, one obtains, by grinding the pure grits and dust, the fairest, whitest flour, a product which it is impossibie to obtain

in any other way. Of this product, there are several grades. These flours bear the name of "extract flours," (selected or *extra* flours; and as they are obtained from the purified grits and dust of the best quality, they are also called "extract grits" and "extract dust;" and since they come from the inner parts of the grain, they bear also the name of "core-grits."

76. The grits-milling seeks to attain slowly to the pure core-grits in that at the first the outer layers are partially separated by pointing or clipping; then the clipped grains are gradually more and more reduced by bruising or cracking. In this way is obtained, as the finest product, the flour; as less fine the dust; after this the grits, solution, and groats are obtained. In all these, in relation to the size of the parts of the different products, all the elements out of which the kernel of grain is constructed are again found; all these products contain particles of the hull-bran.

The fine particles of bran in the flour which give it a dark or grayish-yellow white color cannot be separated by any means. But the case is otherwise with the grits and dust which have been purified with the grits-purifier. The larger particles remaining in the last cracking process are disk-shaped, flat, and have no longer the name of groats, but are called scales, or white stripes. They are, or should be, mainly the honey combed coat from which the sacs of gluten and phosphates have been more or less emptied out.

The starch-cells still clinging to them will be ground off in further operation, by which finally are obtained so-called black flour and coarse bran.

The last results of milling are several kinds of flour and of bran, with which is often a part of grits, particularly finely purified, and called farina.

77. LOW MILLING.—To this process of milling stands opposed the so-called process of low milling, in which the method of production is much simpler, but the flour obtained lacks the whiteness and excellence attained by the Vienna process, or grits-milling.

In low milling, the pointed or clipped grain is passed through stones at the nearest adjustment, by which it is at once and most perfectly ground to the finest flour. It is practicable, however, by careful management of the working between the stones, to obtain a large part of bran and gluten-coats without disintegration, and to separate them from the flour by sifting, and this the more perfectly as by this process of milling finer sieves are employed. Still, it is not possible, at least it has not yet been shown, that this separation of the bran can be carried out so perfectly as to yield an "extract flour" of such fairness as is ordinarily obtained by the process of high milling.

78. In the reduction of the wheat by grinding, the end products are always flour and bran, by whatever process the milling is carried on.

The bran contains the fragments of the outer and inner bran and

the gluten-coat in more finely divided form and with the least possible quantity of adhering starch-cells; such bran is called thoroughly-milled bran, and when obtained from the grits-purifying machine is called floc-bran.

79. The flour consists of starch-grains, fragments of starch-cells, with more or less splinters of the outer coats, or shell, together with the nitrogenous cells of bodies imbedded in the body of the starch.

This result obviously, with numerous differences, according to quantity and excellence, is obtained both by the high and low milling, and whether the mechanical reduction is effected by *stamping*, by *squashing*, or by *friction*. As, however, the outer layers are more coherent and tenacious than the farinaceous interior, held together in thin-walled cells, the reduction of the starch-tissues will be far advanced, while the outer portions are still in large scales. The flour produced, forming a soft medium, protects the outer parts against extreme friction, and it is for this reason impossible, by any mechanical means, to reduce the outer parts as a whole to as fine a condition as the interior mealy part. There will always be found, in the product of the mill, large scales, which, as bran, may be separated by sieves from the flour.

80. The rougher and sharper the rubbing surfaces which reduce the grain are, the more rapid and extreme is the division, as in low milling; and for this reason more of the very fine splinters, or fragments, of the outer coats are found in the product, cannot be separated by the sieve, darken the color of the flour, and make the food prepared from it less palatable.

If, on the contrary, the means for reduction are not rough, and act more by bruising, as is the case with the cylinder-mills, than by tearing, or if the common means of dividing—the millstones—are worked step by step in reduction, as takes place in the Austrian, or high-milling process, then there will be a far better and more perfect separation of the coatings possible, and the flour so produced will be finer and whiter.

81. It is obvious from what has been said that the mechanical devices for the production of flour which must be employed in every mill, group themselves in *means for division* and *means for grading*.

To these must be added the machines which are designed to purify the wheat that is to be ground, such as are employed in the separation of all foreign seeds, shrunken grains, chaff, straw, sand, and smut, the hulling or clipping machines already described, the highly important grits-purifying machines, employed in the grits or high milling, and which, as employed in the low milling or half-high milling in the United States, are known as the middlings-purifiers; and finally certain other co-operating devices for the cooling and preservation of the product, and for facilitating its transportation.

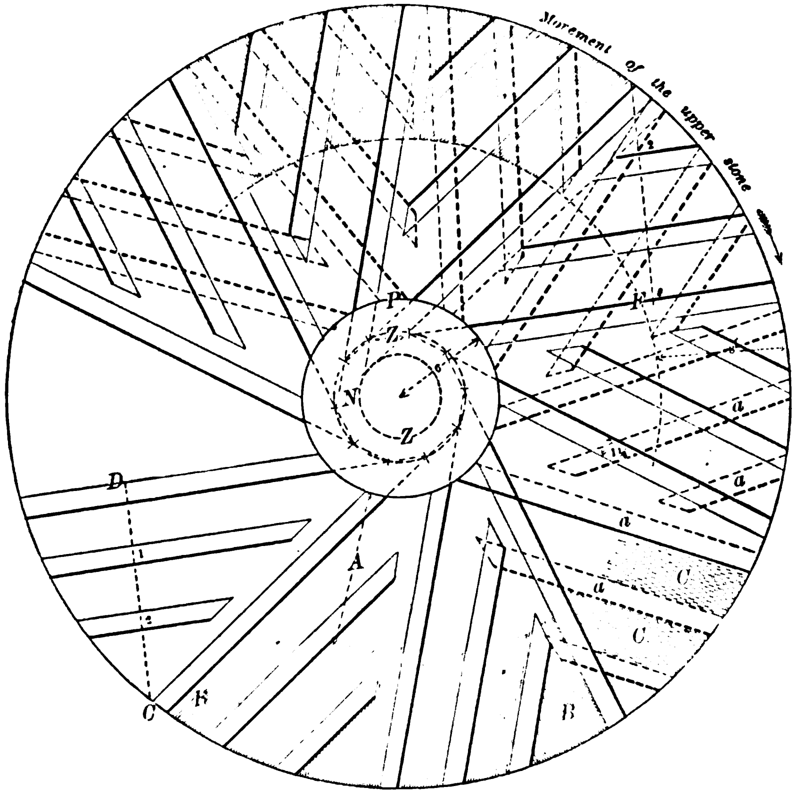
82. MILLSTONES.—There were, on exhibition at Vienna, millstones in great number and variety; some of them were of single blocks or hard stones, including sandstones, basalt, and lava, porphyry and granite.

There were, besides, the burr or French stones composed of fragments of siliceous sinter of varying compactness or porosity, cemented together, which, on account of their hardness and the sharpness of their angles and their porosity yielding sharp edges, are universally preferred to all others, both in Europe and America.

83. Invention has been directed with more or less success in recent times to effect the grinding by the rotation of the lower stone only, and by the rotation in opposite directions of the lower and upper millstones; but, on account of its convenience in facilitating the sharpening of the grooves, the almost universal practice is to confine the movement to the upper stone.

84. The surface of the stone is technically made up of the eye, the bosom, and the skirt; the eye being at the center. The accompanying diagram exhibits the several parts.

Fig. 23.



Surface of stone, with furrows in ten quarters, for high milling. The furrows in dotted outline, *a a*, indicate the upper or running stone; A, the bosom, which is slightly dished toward the eye; B B, the finely-grooved surface of the lands of the skirt of the under stone; C C, the grooved lands of the running stone.

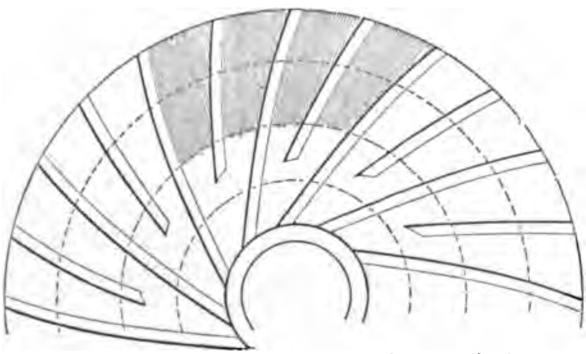
85. The action of the grooves and lands of the upper and lower stones upon each other may be illustrated with the aid of the dia-

gram, (Fig. 23.) The dotted diagram may represent the surface of the lower stone, while the diagram of continuous lines will represent the upper or running stone. It will be seen now, as the eye follows the intersection of any two curves, that the movement of the upper stone will carry the point of intersection to the circumference of the lower stone, as the point of intersection of operating shears is carried from the hinge to the point.

The accumulated meal will be continually pushed forward and outward by the joint action of the upper stone upon the lower and the centrifugal force.

It will be noticed that the grooves, or furrows, which, with the lands, occupy the bosom and skirt of the stone, are of two kinds, long and short. The long ones are not sections of radii from the center, but are tangents from the circumference of interior circles; the short furrows are parallel to the long furrows. The chief grinding surfaces lie in the outer half or skirt; the area of the lands equals or somewhat exceeds that of the furrows. The furrows, instead of being straight, are sometimes curved, as in the following figures:

Fig. 24.

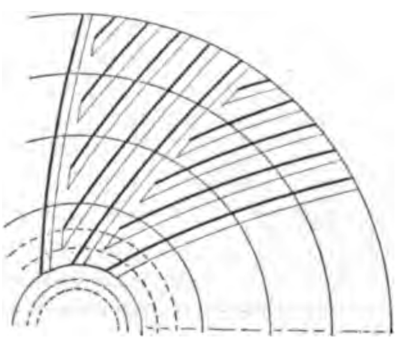


Sketch showing circular grooves of recent device.

These curves are sometimes sectors of circles, sometimes cutting the eye of the stone, and sometimes tangent to it, and in the more recent and improved curved grooves they are sections of logarithmic spirals.

86. The object of the furrows is twofold: first, to provide rough surfaces for the disintegration of grain, tearing or cracking or rubbing; and, secondly, for providing channels for the movement of the crushed grain toward the circumference.

Fig. 25.

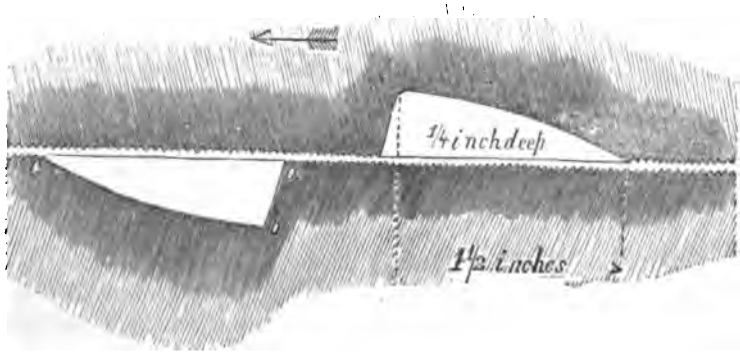


The Evans grooves; logarithmic spirals.

The finer grooves on the lands facilitate the detaching of the friable interior portion of the fragments from the tougher shell. They also serve in giving rotation to the fragments, and thus expose the projecting points to the abrasion of the revolving stone.

87. The accompanying diagram (Fig. 26,) from Kick, illustrates an approved form of the groove; the arrow gives the direction in which the upper stone moves. The depth and width of the furrows are those of the stones in the Thilenius Mill of Cape Girardeau, Missouri.

Fig. 26.



It will be seen that the pulverized grain as it accumulates in the trough *a b c*, will be pushed up along the surface *b c* to the summit of the finely-grooved land beyond, where it will be subjected to trituration till it reaches the next furrow, from which it will, as the furrow fills, be forced out on to the succeeding land.

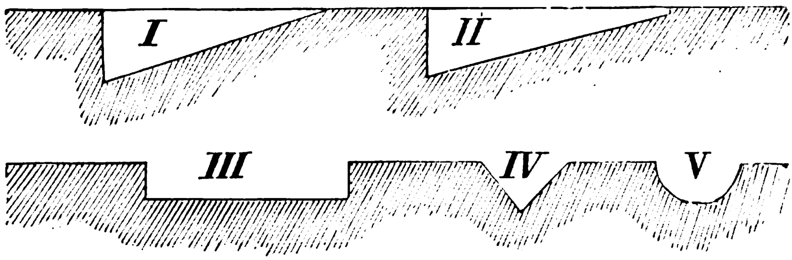
88. The pulverized or ground grain is discharged from the skirt under the influence of the centrifugal force; the velocity of its movement increasing with the distance from the center. This velocity may be checked by nearing the stones to each other, or it may be checked by the conformation of the furrows toward the periphery.

In low milling, with a given velocity of the running stone, the centrifugal force will obviously be antagonized by friction more than in the high milling, and the heat consequent upon the friction will be greater. The temperature of the flour issuing from the stones in ordinary low milling is found to be in the total flour about 120° Fahrenheit.

It is manifest that inasmuch as some portion of the flour, the fine particles for example, are less subjected to friction, other portions, as the gluten-cells, which are larger, must be heated to a very much higher temperature than 120°. To this heat is largely due the vapor of water, which is known to be disengaged in the process of low milling. This doubtless comes from the gluten, which is known to be a hydrate, which parts with its water at a temperature considerably below the temperature of boiling water. This suggests that possibly the accepted superiority of the extract flour by the high-milling process is due to the circumstance that the gluten which it contains has been subjected to less heat and less consequent deterioration than the gluten of the flour produced in the low-milling process. To this point attention will be further directed in considering the adaptation of different grades of flour to the production of bread.

89. The following diagrams (Fig. 27) exhibit various forms of furrows that have been produced in the development of the art of milling.

Fig. 27.



90. The outline of the furrows in their length and section, the comparative breadth of the furrows and lands, the depth of the skirt, and the fine grooving of the lands, the dishing of the bosom, the distance apart of the stones, and the velocity of the runner—all have relations, independent and combined, to the qualities of the grain to be ground; on the most careful attention to which and to the condition of the moisture or dryness of the air depends the successful prosecution of the art of milling. In no other country has such an amount of scientific research been given to this subject as in Hungary, and there very extraordinary results have been obtained.

91. In different mills, these elements are variously combined, some holding tenaciously to the logarithmic spiral, others insisting upon the superiority of the straight furrow, some giving only the faintest dishing to the bosom or none at all, and others limiting the grinding surface to less than the outer half of the milling surface.

In the Istvan steam-mills at Debreczin, under the direction of Prof. E. Pekár, with the stones 54 inches in diameter, and skirt or grinding surface but 9 inches in width, measuring from the periphery along the radius, the very highest order of results has been obtained.

92. In a well-appointed flouring-mill in Brooklyn, N. Y., where low milling is practiced, in which high grades of flour are produced, the furrows have a depth of from three-sixteenths to a quarter of an inch, and are 1½ inches wide; the stones are 4 feet 4 inches in diameter. The long lands are 1¾ inches wide at the circumference, and the short lands 2¾.* The curves of the principal furrows are logarithmic spirals.

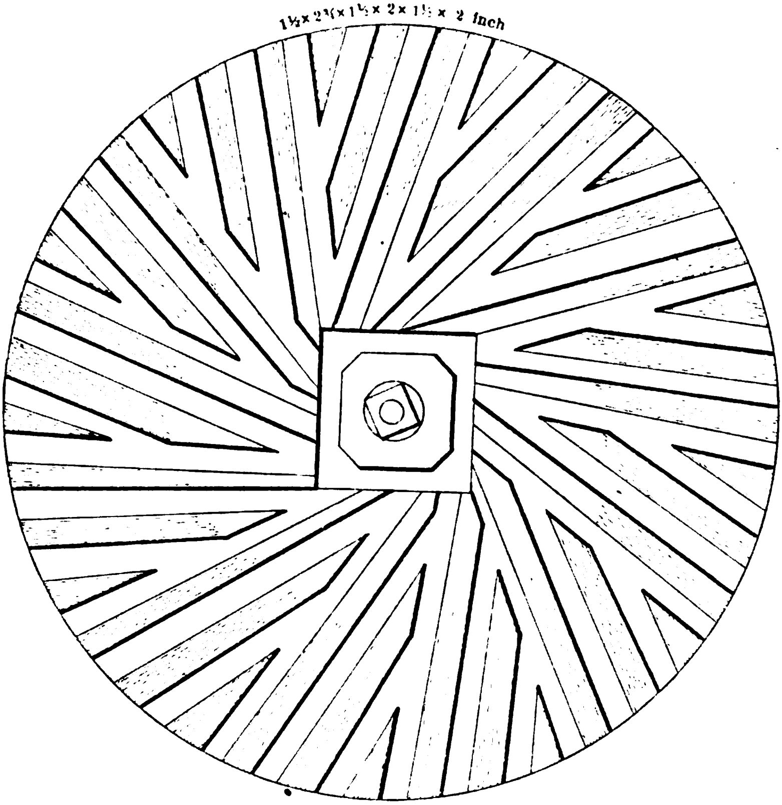
93. The following diagram (Fig. 28) is a copy of the face of the stone of the Thilenius Mill at Cape Girardeau, Missouri, which produced the flour exhibited at the Vienna Exposition. It has been furnished, together with details of the process, in reply to questions addressed to Mr. Thilenius by me.

The dimensions are as follows: The furrows are 1½ inches wide and

* The areas of furrows and of lands are about equal; the lands being perhaps a little larger. The top stone corresponds with the lower exactly in its dressing

¼ of an inch deep. The small lands are 2¾ inches, the others 2 inches wide. The fine grooving of the lands extends from 10 to 12 inches from the periphery toward the center, and has from 30 to 35 creases or fine grooves to an inch. The bush is 10 inches square and the spindle 4

Fig. 28.



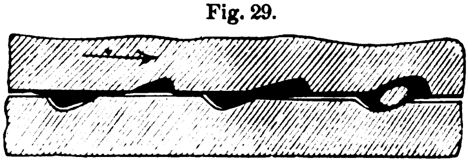
Stone 4 feet in diameter; cutting surface, 13 quarters; fine grooving (skirt) extends from 10 to 12 inches from the periphery and has from 30 to 35 cracks to 1 inch; bush 10 inches square; spindle 4 inches.

inches in diameter. The bed-stone and runner are dished $\frac{1}{48}$ of an inch toward the center. The stones are 4 feet in diameter and make 160 revolutions per minute. The flour as it issues has a temperature of from 110° to 126° Fahrenheit.

94. The next figure (29) exhibits a grain of wheat about to be cracked and crushed by the movement of the upper stone.

The motion from left to right will carry the fragments up the inclined plane to the land, where they will be reduced to a size determined by the distance apart of the stones.

Fig. 29.



95. VENTILATION.—The passage of the wheat from the eye to the grinding-surfaces has been facilitated by a blast of air accompanying the falling grain from the hopper, which serves also to cool the product in the process of grinding. It tends, however, to accumulate the pulverized grain in the path of the blast, and so, by increasing the friction, to neutralize the cooling effect. The quantity of flour produced in a given time is, nevertheless, largely increased. An experiment is recorded in which, without ventilation, seven pairs of millstones ground hourly fourteen hundred and forty-eight pounds of wheat, while with ventilation two thousand and seventy-eight pounds were ground with four pairs of stones in the same time, a ratio in favor of ventilators as nearly 5 : 2. The coal consumed by these two processes showed a saving with ventilation of 23 per cent. The trustworthiness of these results is questioned by Professor Kick. The ventilation may be effected either by a blast from compressed air; by suction—drawing the air from the eye to the circumference; by a combination of blast and suction; or by the introduction of air between the grinding-surfaces through openings in the running stone. This expedient is not resorted to—as it is not needed—in the Hungarian milling.

96. THE COOLING OF THE FLOUR.—The temperature of the pulverized product as it issues from between the stones has already been alluded to as a consequent of the friction attendant upon the process of grinding. The ventilation, mingling a current of air with the pulverized grain, tends to restore the normal temperature. This principle is applied on a larger scale after the grinding, where mechanical appliances are introduced to stir the meal, and continually bring fresh surfaces in contact with the air. The familiar hopper-boy, which is a sort of great rake, so operated as to stir up a layer of meal of moderate depth, has been adopted from America into Germany.

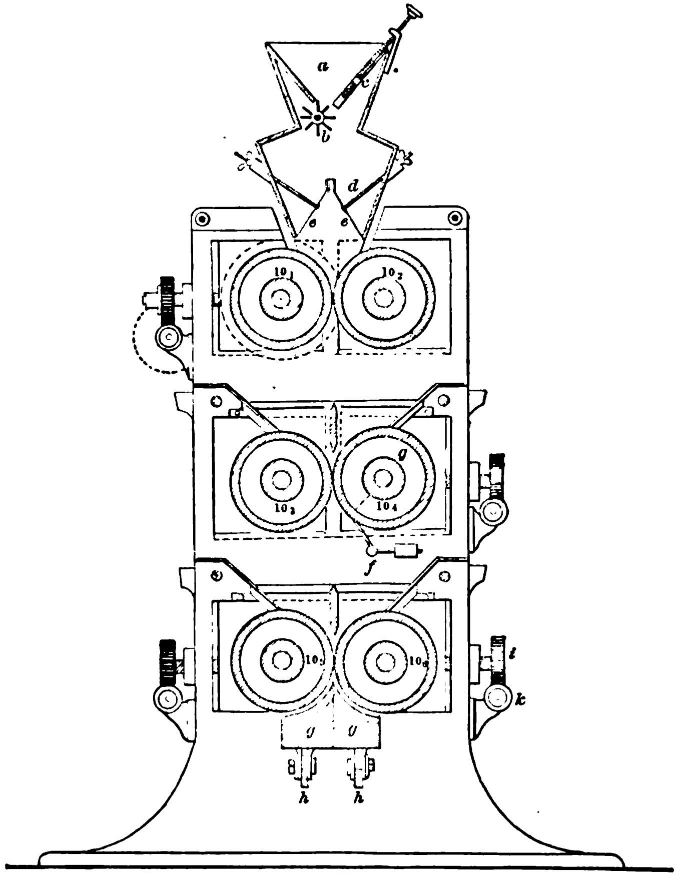
97. As the friction is greater and the temperature higher in the low-milling than in the high-milling process, the necessity of cooling the product of the former is greater. Indeed, such cooling has been deemed indispensable to the preservation of the flour. In the high-milling process, where the quantity of flour produced to a single pair of stones is relatively small, no special arrangement for cooling is necessary, since the alternate grinding and bolting, as the successive steps of the process advance, prevent the temperature of the product from rising above the margin of safety.

98. THE CYLINDER-MILLING.—This is more especially true of the cylinder-milling, where the successive steps in the reduction of the wheat are very numerous and alternate regularly with the cooling process. The cylinder or roller mill, or *Walzenmühle*, of the Hungarians consists in its simplest elements of two small parallel, horizontally-disposed steel cylinders, placed near to each other, arranged for adjustment, and revolving from above toward each other. The cylinders in the great Pesth *Walzenmühle*, the flour from which won the highest distinction at Vienna,

were not more than five inches in diameter; the surfaces of some of them were traversed by numerous sharp furrows, or, which is the same thing, numerous sharp ridges parallel to the axis; others were smooth.

99. The accompanying diagram (Fig. 30) exhibits three pairs of roll-

Fig. 30.



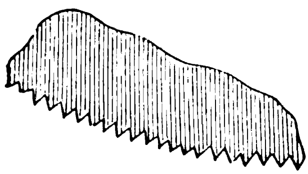
ers, one above another, in a set, showing how the grain, in passing from one pair of cylinders to the next, passes through an intervening body of air, and how the slight heat developed by the pressure between one pair of cylinders may be overcome by the cooling effect of the air through which it passes on its way to the next pair of cylinders.

The smooth cylinders, revolving with uniform speed, if near enough together would crush the grain to flatness; if revolving with unequal velocity, the tendency would be to squash the grain; with grooved cylinders, the tendency is to indent and crack the grain where the velocity of the two cylinders is the same. Where the fluted or furrowed rollers revolve with unequal velocities, the action is frictional. The action

depends as well upon their distance from each other as upon the character of their surface.

100. If smooth cylinders are so far apart that the pressure is but slight, the berry will split open along the groove throughout its length, the two halves frequently clinging together, somewhat suggesting an open book; if the cylinders are nearer together, soft wheat will be flattened, hard wheat will be cracked into fragments, and the grits will be freer from bran than when obtained by grinding between stones. The following diagram (Fig. 31) presents a profile of the grooved surface of a roller of large diameter:

Fig. 31.



101. The essential advantage of the *Walz* or cylinder milling is that the product is *not heated;* it is a process of cold milling. It is also to be remarked that there is no dust-flour produced.

In the great Pesth *Walzenmühle*, under the direction of Dosswald of the international jury, the wheat, before attaining its last disintegration, passed through from eighteen to twenty-four pairs of cylinders. The product of grits, flour of various grades, and bran was obtained from the Hungarian commissioner at the Exposition, and analyses have been made, which will appear in their proper place farther on.

102. In Wyngaert's journal "*Die Mühle*," of December, 1874, and January, 1875, an account is given of an improved *Walzenmühle*, the work of an Italian inventor, Wegmann, in which the cylinders are of porcelain and the space between the cylinders controlled by springs, (formerly by levers and weights as shown in the diagrams,) which, in the judgment of Wyngaert, promises to be of great value.

Wyngaert says there is practically no heating of the product, and that the gluten retains its normal qualities; that the bran is subjected to no tearing process, but is flattened out, and the interior portion pressed away so that the middlings-purifier is rendered unnecessary; that the yield of first flour is greatly increased; that the effect of the adoption of the porcelain *Walzenmühle* on the low milling will be to change it to half-high milling; and the effect of it on high milling will be to reduce the number of grades of flour, a consummation greatly to be desired.

Wyngaert sums up the advantages of Wegmann's porcelain-cylinder mill, as shown in a series of special experiments undertaken at his instance and under his direction, as follows:

1. It renders unnecessary the whole system of grits and middlings purifiers.

2. It secures a larger proportion of clear, pure flour.

3. It makes it impossible to injure the quality of the flour in milling.

103. The accompanying figures illustrate in some degree the construction of the porcelain-cylinder mill.

Fig. 32 is a sectional view. Fig. 33 is a view from above. Fig. 34 is a side-view. In Fig. 32, *a* shows the feed-cylinder; *b*, the porcelain cyl-

Fig. 32.

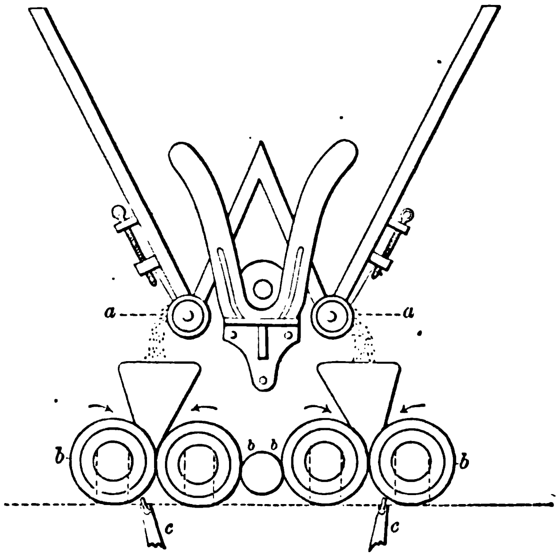
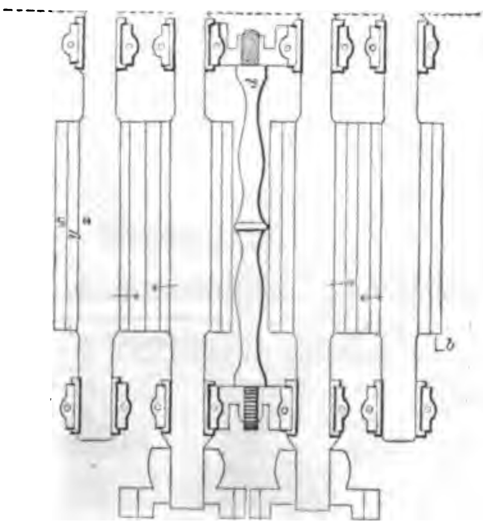
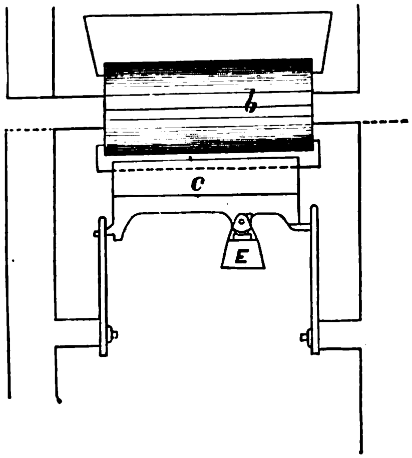


Fig. 33.



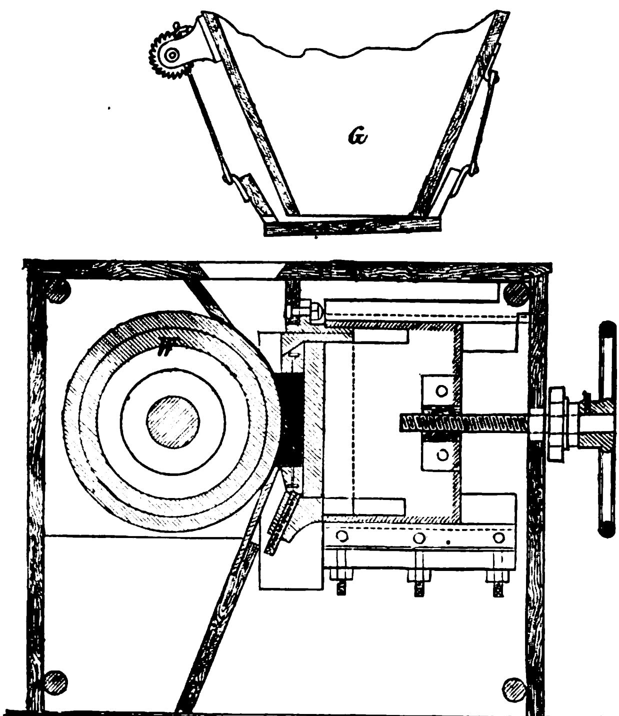
inders; *c*, the scraper with glass edge. In Fig. 33, *d* shows the coupling-bolts of the uprights; *x*, the porcelain shell; *y*, the lead interior shell; *e*, the axle. In Fig. 34, *b* is the porcelain shell; *c*, the scraper, with the weight *e* to secure the glass edge against the porcelain surface. The figures are one-tenth the size of the actual machinery.

Fig. 34.



104. The *Walzenmühle*, or grits-mill, with one cylinder, from the St. Georgen Manufactory at St. Gallen, was on exhibition. It is presented in the accompanying figure, (35.)

Fig. 35.

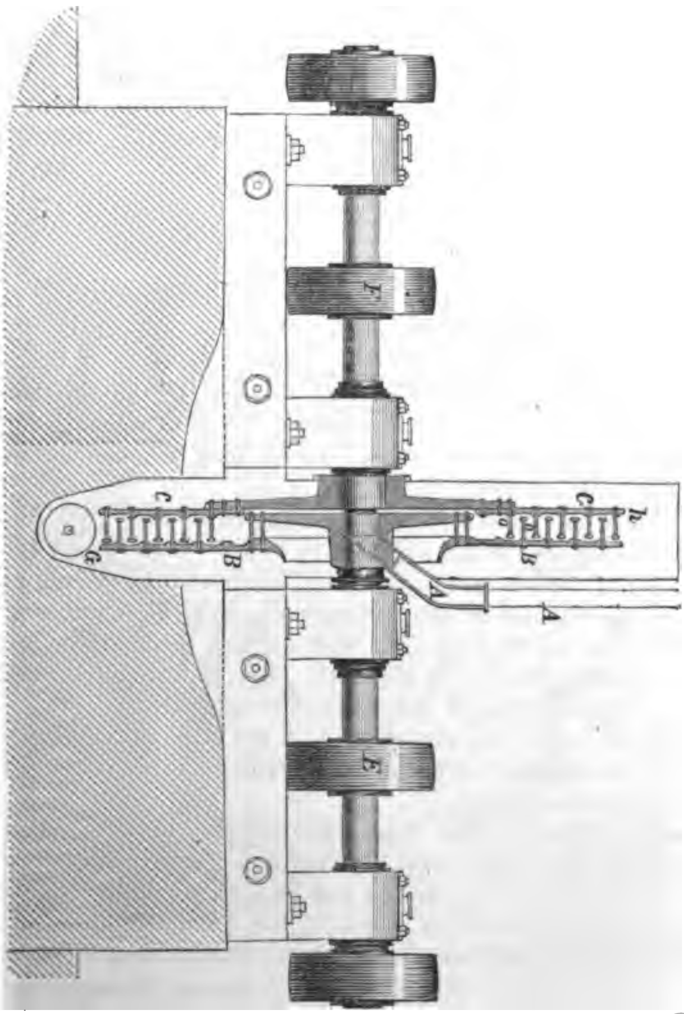


Cylinder-mill of St. Georgen, St. Gallen, Switzerland.

W is the cylinder, with steel shell, and S is the steel concave. It is used only for the purpose of cracking the grain and the production of grits, leaving the further milling to be pursued with runs of stones.

105. Disintegrator.—Beside the two great systems of milling—the high (I) and low, (II,) which differ from each other in the distance apart of the upper and lower stones, and the *Walz* or cylinder milling, (III,) there is (IV) a system of disintegration, in which there are neither stones nor cylinders, but in which the pulverization is effected by friction of the grain upon itself, the wheat being kept in motion by beaters revolving at high velocity in a hollow cylinder. The product in a given time with a given expenditure of power is said to be very large. It has not been widely introduced.

Fig. 36.



Carr's disintegrator, or centrifugal mill.

Kick's Vienna Report, after analyzing the work of Carr's centrifugal disintegrator, gives it a secondary place, as compared with the work of the high milling with runs of stone or the cylinder-mill. The diagram (Fig. 36) exhibits a section of one of the forms of this apparatus at the Exposition.

106. SUMMARY.—The extreme *low* milling is a system of *mashing* and repeated scraping and squeezing and a single bolting. It is attended with heating of the product, which injures the flour.

The *high* milling is a system of successive crackings with alternate removal of the finer particles and the bran as fast as produced. It is attended with but little heating of the product. There is some cracking in low milling and some mashing in high milling.

The *half-high* milling, as its name imports, partakes more of the cracking than low milling, and more of the scraping and squeezing than high milling.

The cylinder-milling is a system of pressing and cracking, and, where the cylinders are grooved and move with unequal velocities, of tearing. Like the high milling, it produces little heat.

107. SIFTING OR BOLTING OF THE PRODUCTS OF GRINDING.—The bolting process to which the product of the grinding is subjected immediately after cooling, has for its object in the low-milling process to get the largest possible amount of flour, and of course the smallest amount of bran.

In high milling, bolting or sifting has various objects to accomplish. As the grain is reduced by successive grindings into groats, grits, and flour, between each two steps in the grinding process there must be one or more gradings, boltings, or siftings to separate the products from each other; and, to complete the process, sieves of varying degrees of fineness are employed; the coarser sieves may be made of wire, but all the finer ones are for the most part of silk.

The sizes of the openings in the bolting-cloth vary from three hundred and twenty-four in the square inch to more than twenty thousand. The number of meshes in a square inch is indicated by certain numbers qualifying the fineness of the bolting-cloth, and these numbers should be employed to indicate the flour which passes through the meshes of the corresponding numbers of the cloth. But, unfortunately, this is not the case; the numbering of the flours is quite arbitrary.

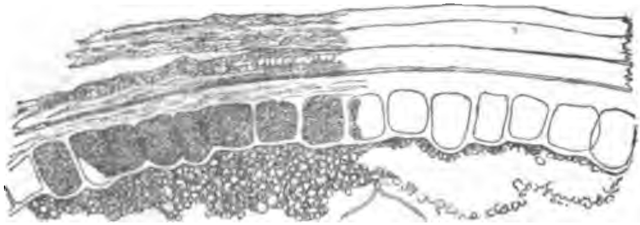
The numbers upon the wire-cloth and the grits silk gauze indicate the number of meshes in a linear inch. The numbers of the silk bolt-cloth are entirely arbitrary.

108. BRAN-DUSTER.—The brush-sieve consists of a wire-gauze cylinder; within this fixed drum is a revolving axle making from two hundred and fifty to two hundred and seventy revolutions in a minute, and carrying with it cast-iron rings, at the circumference of which is attached a series of bars bearing brushes. The office of the brushes is

to rub off the flour from the bran, and drive the flour through the fine wire-gauze, while the bran is permitted to pass on.

109. The proportion of flour of the white interior of the grain adhering to ordinary miller's bran, before subjection to the bran-duster, is indicated in the accompanying cut, (Fig. 37.)

Fig. 37.



Transverse section of a scale of millers' bran, magnified to 150 diameters; drawn under the Camera Lucida, part being left in outline only.

110. THE FLOUR-BOLT.—The construction of the flour-bolt, whether round or hexagonal, whether single or double, whether in connection with interior screws for the movement of the flour, and the disposition of the bolting-cloth of different degrees of fineness, would lie without the scope of the present report.

The problem presenting itself in the separation of the various products resulting from the processes of reduction in high milling will be apparent from a consideration of the following diagrams. They illustrate at a glance some of the important stages through which the grain passes on its way from wheat to flour and bran.

Fig. 38 exhibits the result of the first cracking of the berry or pointing. The stones were at the maximum distance apart for removing the brush. The product has been freed from the hairs or bristles, more or less of the outer bran-scales, fine flour, and whatever minute particles had been detached in running through the stones. It is purified. In Fig. 39, we have the result of the second cracking, purified.

Fig. 38.

Fig. 39.

Fig. 40.

Fig. 41.

In Fig. 40, we have the product of the fourth cracking, precisely as it came from between the stones. One sees what was the condition of the grits of Fig. 43 and Fig. 45 before they were purified. In Fig. 41, we

have the coarse solution, a mixture of groats and grits. In Fig. 42, we have the *medium solution*—of groats and grits.

In Fig. 43, we have grits No. 1, or farina, or semolina; and, in Fig. 45, we have grits much finer—No. 5.

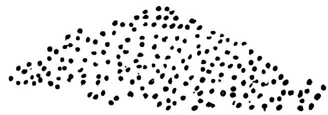
In Fig. 44, we have the bran, which has been ground and scrubbed, and as far as possible exhausted to the gluten-coat.

Fig. 42.

Fig. 43.

Fig. 44.

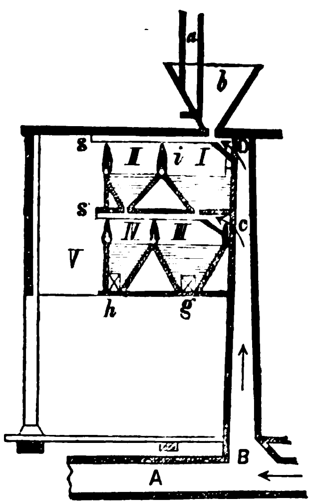
Fig. 45.



111. **The purification of the grits.**—The separation of the grits from the bran-scales of equal size is so distinctly of Austrian or Hungarian origin, and so essential to the production of the high grades of flour from which the excellent Vienna bread is produced, as to justify the attempt to present an outline of some of the principal devices by which this separation is effected. These products differ from each other in essential particulars. The bran is the shell of the wheat. The grits are fragments from the interior.

To the bran proper, there are adhering much of the gluten-coat and some of the starch of the interior. To the grits, there are sometimes still adhering portions of the gluten and occasionally of the other outer coats of the wheat.

Fig. 46.



112. The bran is thin and flat, or consists of scales; the grits are irregular fragments of the grain, roundish or granular. The bran is specifically lighter than the grits, and presents, relatively to its weight, a much greater extent of surface.

Upon these differences rest the separation of the bran from the grits. The agencies employed are, first, the current of air, produced either by blast or suction; and, secondly, centrifugal force.

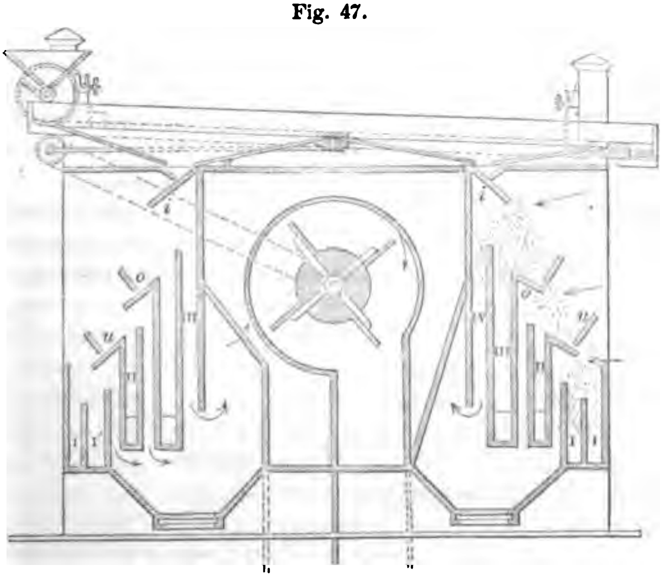
The current of air is directed against a thin stream of falling mixed bran and grits. All the particles are blown out of the perpendicular—the heaviest least, the lightest most. The bran, presenting the largest amount of surface with a given amount of material, is driven farthest;

the grits, presenting a less extent of surface relative to the amount of material, fall nearest to the perpendicular. Between these is an intermediate portion.

The preceding cut (Fig. 46) exhibits a machine substantially the device of Ignaz Paur, the discoverer of the process of high milling. It has been already partially described. *b* is a hopper having a long narrow slit at the bottom. *a* is a flat supply-tube, with an adjustable slide for the supply of the mixed bran and grits. Through the opening *d*, a current of air encounters the cascade of falling bran and grits. The grits fall into the division *I*, the bran is carried on to the division *V*, and the intermediate portion falls into the division *I I*. The current of air entering at *c* subjects the grits and intermediate portion from *I* and *I I* to a second purifying operation.

Bauer's exhaust grits-purifier and Escher Wys's grits-purifier are selected by Professor Kick in his report on Group IV to the Austrian government, from the vast number on exhibition. They are shown in the diagrams, (Fig. 47 and Fig. 48.) It may be questionable whether such extreme grading of products as must result in Bauer's apparatus is desirable.

Fig. 47.

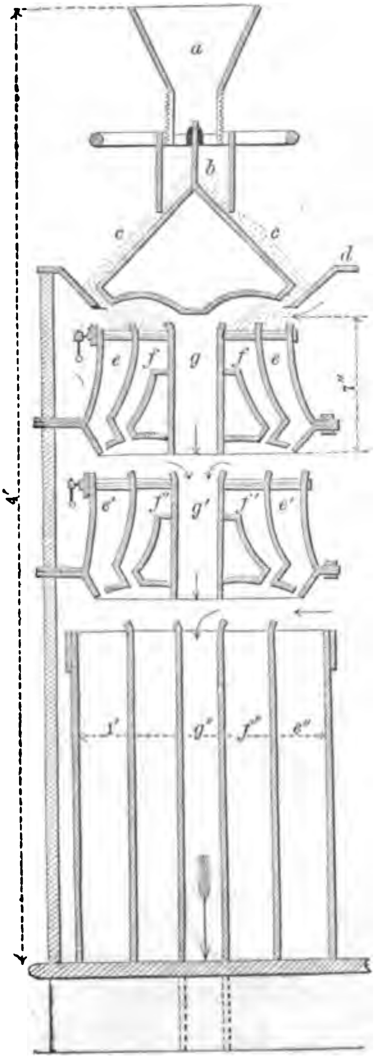


Bauer's exhaust grits purifier.

113. In the great *Walzmühle* at Pesth, there was an apparatus which the annexed diagram (Fig. 49) will illustrate: A is a hopper receiving the meal; B is a cylinder fitting the spout from the hopper and admitting of raising or lowering; *b* is a circular, smooth, metallic plate revolved by a vertical shaft attached below. The meal, as it issues from the foot of the hollow cylinder with increasing velocity, is carried to the periphery, and shot outward into a current of air produced by suction through the spout H. The rounded grits, having greatest weight in proportion to

the extent of surface, reach the space D; the bran-flakes, having least material to surface, are drawn to F; and the fine flour falls between to the receptacle H.

Fig. 48.

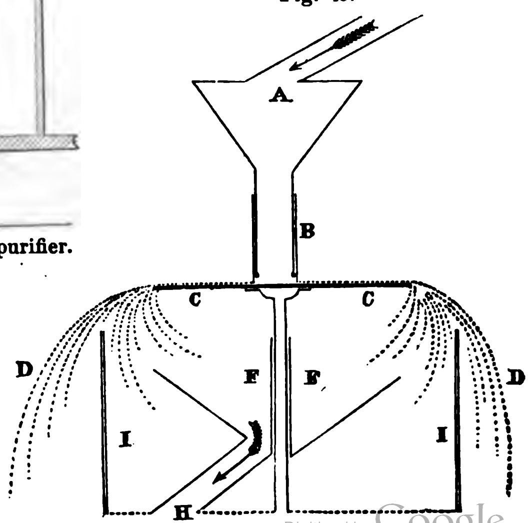


Escher Wyss & Co.'s grits purifier.

114. Another device has been contrived for separating the minute bran-scales from the grits of equal size, by causing a broad stream of air, either by blast or suction, to pass through a slightly-inclined plane sieve of meshes sufficiently large for both the bran and grits to pass through; the force of the blast being so gentle as to permit the grits to drop, while the particles of bran are kept afloat to be discharged at the lower margin of the sieve. The sieve is sometimes disposed around a cylinder, and the action promoted by a brush acting upon the surface of the sieve in connection with the blast or suction. Of this class, several of most ingenious construction, under the name of middlings-purifiers, have been recently invented and brought into use in this country. The accompanying figure (50) illustrates one of the simpler forms.

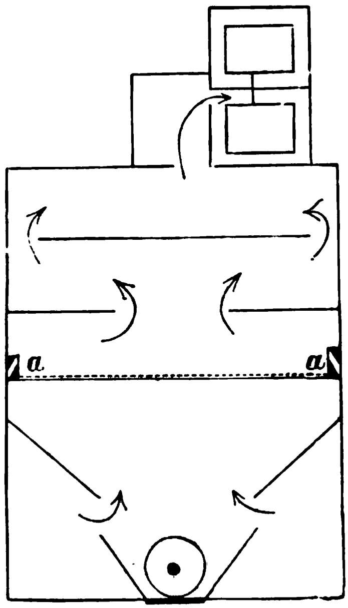
a a, the slightly-inclined sieve, through which the air is carried upward by the exhaust-fan, by which the fine bran is

Fig. 49.



prevented from passing through, while the heavier purified middlings are dropped to the trough below.

Fig. 50.



115. THE PRODUCTS OF THE TWO PROCESSES OF LOW MILLING AND HIGH MILLING.—The relative merits of these two modes of milling have been discussed at great length and with signal ability by the Austrian and German millers. Foremost among those in asserting and expounding the just claims of the process of low milling with its recent and most improved appliances is the distinguished Joseph J. van den Wyngaert, editor of the German journal "*Die Mühle*," and member of the international jury, Group IV, Division—Flour and its Products, &c. In his numerous papers, he has set forth with great clearness and force the principle that the question of relative superiority is not to be determined upon purely scientific principles alone; but that inasmuch as milling, as a great practical art, is intimately connected with the every-day life of the whole community, it must be first of all self-sustaining; it must provide a flour for which there is sufficient demand to yield a living-profit to the miller, over and above the cost of the grain and its working, including the various tariffs, the interest upon capital, and the expense for repairs; in other words, that it will not do to produce an article, however attractive to the scientific mind, for which there is little or no remunerating demand on the part of consumers. In the second place, he holds that inasmuch as the Austro-Hungarian process of disintegration of tissues is a process of successive crackings, it is especially suited to a hard and brittle wheat, which is the principal wheat in the markets of Vienna and Pesth, and is not suited to the softer varieties of wheat, which are more abundant in North Germany, England, and the United States, and which consist of a tougher shell and a more mealy and friable interior. He cites instances in which mills erected with the appliances for high milling, because of their not being found self-sustaining, have been converted into mills with the conveniences for low milling.

He presents ("*Stenographischer Bericht der sechsten Versammlung deutscher Müller und Mühlen-Interessenten*") a series of tables illustrating the production of various high and low milling establishments in Baden and Bavaria, with the cost of wheat ground, the amounts and kinds of products turned out, the cost of grinding and fitting for market, and the receipts from sales, in which the profits of the low milling are, according

to the figures, decidedly greater. He submits also the result of a series of experiments in baking with the different kinds of flour, and reaches the conclusion from them and from the relative profits, that low milling, at least for the wheat of Northern Germany, that is, as of softer wheat distinguished from hard, is more profitable than high milling would be.

He dwells upon the fact that the hard, flinty wheat is chiefly a matter of climate, and that crops in the same district vary in their hardness on the different soils and even in the same fields in different years, and to some extent according to the character of the preceding crops.

Wyngaert gives due prominence, in seeking an explanation of the excellence of the Vienna bread, also to the beautiful white press-yeast with which the Austro-Hungarian bakers are supplied.

116. The physical impracticability of producing lumps from the friable interior of the soft wheat shows at a glance the inferior adaptation of this kind of wheat to the production of the numerous grades of grits which characterize the Austro-Hungarian milling. The toughness of the shell of the soft wheat makes it practicable to obtain a product in low milling in which the fine particles of bran are relatively few, and from which a flour of high order of whiteness may be obtained. The dry, brittle Hungarian wheat, subjected to the low-milling process, would, by reason of the brittleness of the shell, yield a product in which the small particles of bran would be numerous, and, being of the same size, would pass through the bolt with the flour, and make it impossible to produce a flour of perfect whiteness. By moistening the Hungarian wheat, however, before grinding, the toughness of the shell would be increased, its reduction to fine particles in the process of grinding would be less, and the flour would be made whiter.

117. The advocates of high milling rest upon the claims of the scientific solution of the problem: the reduction of the wheat-grain by a succession of alternate crackings and sortings, in which disintegration is effected by successive steps of such slight individual advance, and the graduations of the successive products are so fine that the heat produced is inconsiderable, and the ultimate product of flour free from specks and of absolute fairness is much larger than by the low-milling process. The significance of this peculiarity of the process cannot be easily overestimated. It leaves the integrity of the cells of gluten unimpaired. They have, therefore, their natural investment of cellular tissue to protect the sensitive nitrogenous constituents of the interior from the oxygen of the air, and from the spores of microscopic vegetation always afloat in the atmosphere. Having escaped destructive crushing, they have also escaped the heat attendant upon it, and the loss of water and chemical decomposition due to it. As the chemical changes consequent upon this exposure of the gluten bring with them products of disagreeable taste and smell, the flour produced by the high milling has escaped the deterioration consequent upon the destruction of the texture of the gluten-cells.

118. From the researches of Mégé Mouriès, already referred to, it would appear that the gluten-comb of the grain contains a nitrogenous constituent of great susceptibility to fermentation upon the application of water, in which it is soluble. This body, so long as the cells containing the gluten remain intact, is protected from the moisture of the air. The importance of maintaining these cells unbroken in the flour until it is to be converted into bread needs no illustration.

The defense of the theory of high milling, where the hardness of the grain renders it practicable, seems perfect.

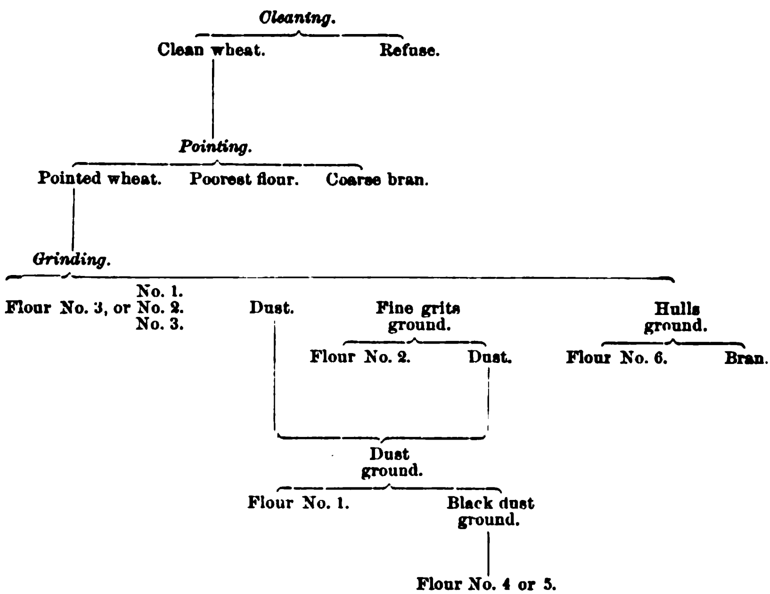
119. The inferior adaptation of the process of high milling to the softer varieties of wheat has led to a compromise between the two processes, called half-high milling, already referred to, in which the advantages of the principles of high milling are recognized and the necessary profits of the miller to make his art self-sustaining are maintained.

120. After all that may be written, one is forcibly impressed with the conviction that, as in every kindred case, there will remain an unwritten art, which is only to be acquired by actual contact day by day, for long periods, with all the details of the business.

In the art of the miller, it must continue from the selection of the grain to the sale of the flour, upon which scientific treatment and commercial success depend and are made to harmonize with each other.

121. PROPORTIONS OF THE DIFFERENT GRADES OF FLOUR YIELDED BY THE HIGH AND LOW MILLING PROCESSES.—By the processes of low milling, we have the following scheme of treatment:

Table showing the course of ordinary low milling.



Wyngaert gives the quantities of these products as—

75 per cent. of No. 0;
5 per cent. of No. 1;
7 per cent. of bran;
11 per cent. of scales or hulls;
2 per cent. of loss;

Making 100 parts of the whole.

Kick gives them as—

73 per cent. of flour, Nos. 1, 2, and 3;
7 per cent. of flour, Nos. 4 and 6;
17 per cent. of bran and dust-flour;
3 per cent. of loss.

This table exhibits the method of low milling as given by Kick. It is, however, in some localities conducted with a detail and refinement which involves a much greater consumption of power and a much increased variety of products.

122. LOW MILLING.—The scheme shown in the opposite table, as compiled by Wyngaert, represented what in Germany in 1870 was known as the American or low-milling method.

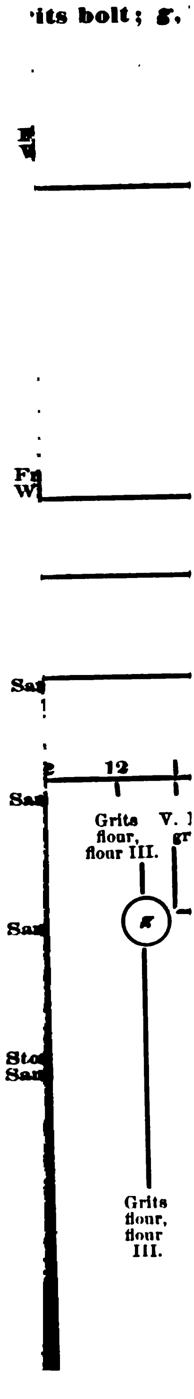
The wheat is purified, by which the foreign seeds, dirt, and blasted kernels are removed. It is then pointed, or clipped, and then, in some mills, before entering the run of crackers, or groats-run, is passed between iron cylinders, which facilitate the subsequent reduction. The product, as it issues from the cracker or groats run, has a woolly rather than a gritty feel, and the coarse bran remains in large pieces. The groats are then treated as shown in the following table:

123. The processes of purification do not vary essentially from those of the Hungarian or high-milling method.

In some of the best-appointed mills in this country, (United States,) the grits or purified middlings are conducted back and discharged into the hopper with the pointed wheat. In others, the grits, which are produced in the process of half-high milling to the extent of 20 per cent. or more of the weight of the whole wheat, are ground separately, and then mixed with the residual 50 to 60 per cent. flour, in such proportions as may be determined, to give a flour of special excellence, indicated by the brand.

124. There is grown, in the State of Minnesota, a variety of spring-wheat, known as the "Fife" wheat. The berry is small, red, plump, and hard. It is distinguished on account of the extent to which the outer true bran-coat may be separated in the preliminary process of milling, without abrading the gluten-coat.

The following scheme shows the steps of the milling process as pursued in a first-class mill employing this variety of wheat:


its bolt; g,
12
Grits flour, flour III.
Grits flour, flour III.

Commercial wheat.

Separator.

Purified wheat. | Chicken-feed.

Smut-machine.

Clipped wheat. | Dust, hairs, &c.

between

Scouring-brush and stone and blower.

Unbranned wheat. | Scales of true bran, longitudinal and transverse cells, (cigar-coat.)

First run of stones.

Wheat-meal.

Bran. | Middlings and flour.

Purified middlings. | Refuse sold as feed, but containing much grits.

First grinding.

Second middlings—flour.

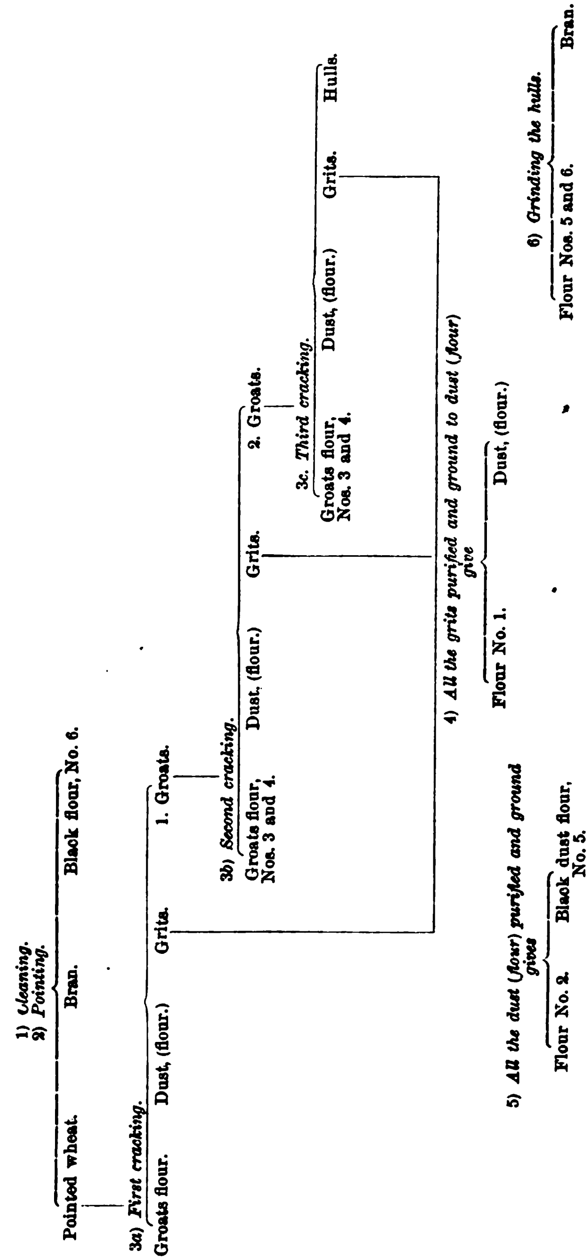
Second grinding.

Best middlings flour.

The best middlings flour is about 25 per cent. of the wheat. The remaining flour is about 50 per cent., not so rich in gluten, but of excellent quality.

125. HIGH MILLING.—In the process of high milling, it will be remembered that in the step by step reduction of the grain, starting with the pointed kernels, we have with each grinding three products: coarse fragments, with much bran attached; less coarse fragments, with less bran attached; and minute fragments, with little or no bran attached. These are separated from each other by the sifting and purifying machines. Each of the several products is again subjected to grinding, and the product in each case again sorted into grades, and so on, until the last traces of the white interior of the berry have been separated from the dark hull and graded.

126. The following scheme exhibits the products yielded in a comparatively primitive high-milling establishment, where the details are very much less extended than in the larger and more perfect Austro-Hungarian mills, in which the processes are carried out to the last degree of refinement.



1) Cleaning.
2) Pointing.
Pointed wheat.
Bran.
Black flour, No. 6.
3a) First cracking.
Groats flour.
Dust, (flour.)
Grits.
1. Groats.
3b) Second cracking.
Groats flour, Nos. 3 and 4.
Dust, (flour.)
Grits.
2. Groats.
3c. Third cracking.
Groats flour, Nos. 3 and 4.
Dust, (flour.)
Grits.
Hulls.
4) All the grits purified and ground to dust (flour) give
Flour No. 1.
Dust, (flour.)
5) All the dust (flour) purified and ground gives
Flour No. 2.
Black dust flour, No. 5.
6) Grinding the hulls.
Flour Nos. 5 and 6.
Bran.

COMBES.

3) FIRST TO THE FOURTH CRACKING.

FIRST C

Flour

Dust.

Grits. → to be further twice ground, (see below.)

dust,

Coarse

4) GRINDING OF THE FRAGMENTS, (coarse, medium, and small solutions.)

By its

Flour

Dust.

Grits.

In such a mill, the fine extract flour of grades Nos. 00 and 0 will not be obtained at all. Kick expresses a doubt whether the product thus obtained is superior to that of a well-appointed low-milling arrangement.

127. In the accompanying table, there are given the successive steps of the various processes by which wheat is milled in a thoroughly-appointed Hungarian mill.

To a layman like the writer, such a scheme seems almost bewildering in its repetition and detail, in its division and distribution of products, and their final collection and gradation. It is to be remembered, however, that the movement of the various products by means of horizontal transferring screw-work, in connection with elevators, shoots, and switches, becomes a mere matter of power in the engine.

128. It is to the circumstance of the comparatively recent development of the high-milling process in Southern Germany that the designation by numbers is not a more absolute guide in determining the actual value of the grades of flour to which these numbers are attached. Bakers were accustomed to speak of the products of the Austrian or Hungarian high milling as being of ten grades; but, in the products of the Hungarian *Walzmühle* at the Exposition, there were altogether twelve, including the groats and two grades of bran; while in the mills at Debreczin, already referred to, the subdivision was greater still.

129. In deciding upon the relative excellence of the products of the different mills submitted to the International Jury, the comparison was made, as already stated, with the best 45 per cent. of the product. This included, in the Debreczin mills, the three grades of grits, the 0 grade of flour, and the first five numbers. These were distributed as follows:

	Per cent.
A, B, C grits, and flour No. 0	6
Flour No. 1	6
Flour No. 2	6
Flour No. 3	7
Flour No. 4	9
Flour No. 5	11
	45

The remaining grades were as follows:

	Per cent.
Flour No. 6	12.0
Flour No. 7	10.0
Flour No. 8	8.0
Foot-flour No. 9	1.0
Flour No. 10	0.5
II.	
Bran	20.0
Dust	0.5
Evaporated	3.0

In the products of the Hungarian mills in Prague, the 45 per cent. includes:

	Per cent.
Flour No. 00, Flour No. 0	18.9
Flour No. 1	13.8
Flour No. 2	8.6
Flour No. 2½	4.5
	45.8

130. It is obvious that for commercial purposes, where the grades making up the best 45 per cent. are to be mixed together, the finer graduation would not be recognized, and as a matter of practice the flour used for the Kaiser *Semmel* or Imperial rolls in the Vienna bakery at the Exposition rarely fell much below the best 45 per cent. of high-milled Hungarian wheat. It is from this 45 per cent., or from more or less of the higher grades included in it, that the famous Vienna bread is made.

131. The names or numbers and the percentages corresponding to these numbers as produced at the Prague high-milling establishment are:

Flour No. 00, imperial extra.

Flour No. 0, extra flour.

Flour No. 1, Flour No. 2, baker's extra or fine flour.

Flour No. 3, fine flour.

Flour No. 4, roll-flour.

Flour No. 5, white pollen.

Flour No. 6, black pollen or bran and foot-flour or sweepings together.

Wyngaert, in "*Die Mühle*," No. 36, 1870, gives the following proportions of the different products yielded by the Hungarian high-milling process, which, it will be seen, are apparently inferior to the results obtained at the Debreczin mills.

	There were produced—	From wheat of average weight. 83 to 84 pounds per metze.	87 to 88 pounds per metze.
		Per cent.	*Per cent.*
A	Lady-groats		
B	Table-groats, fine	4.25	5.00
C	Table-groats, coarse		
0	Extra imperial flour		
I	Extra fine flour	5.53	5.75
II	Ordinary fine flour	5.76	6.25
III	Extra roll or semmel flour	5.51	6.75
IV	Common roll or semmel flour	6.48	7.75
V	First pollen flour	7.12	7.50
VI	Second pollen flour	13.30	15.00
VII	First dust-flour	11.85	11.00
VIII	Second dust-flour	9.95	8.75
IX	Brown pollen flour	4.36	2.25
X	Foot-flour	6.32	4.25
F	Fine bran	8.94	9.40
G	Coarse bran	6.87	7.25
H	Chicken-feed, loss, and dirt	3.76	3.10
		100.00	100.00

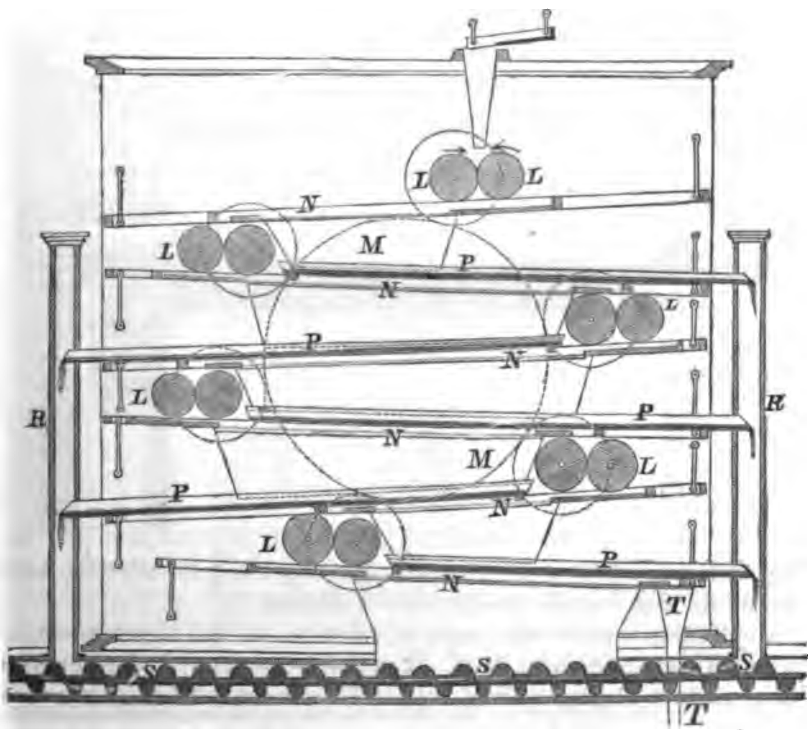
According to this, there would be an average produced from 100 pounds of wheat of from 34 to 39 per cent. of the better grades of flour.

132. From a comparison of these two tables with that of the Prague Hungarian mill, given by Kick and presented below, it will be seen that the numbers afford at the best but an imperfect guide. The Prague and Debreczin mills yield 45 per cent. of the choicer grades, while the results of the mills cited by Wyngaert give an average, as shown above, of 34 to 39 per cent.

Flour No. 00, imperial extra; Flour No. 0, extra	18.9	45.8
Flour No. 1, baker's extra	13.8	
Flour No. 2, baker's extra	8.6	
Flour No. 2½, baker's extra	4.5	
Flour No. 3, fine flour	12.6	
Flour No. 4, roll or semmel flour	11.9	
Flour No. 5, white pollen	7.3	
Flour No. 6, black pollen	4.5	
Bran and sweepings	16.4	
	98.5	

133. BUCHHOLZ CYLINDER-MILLS.—There has appeared in England a combination of the grinding and bolting processes of great apparent

Fig. 51.



simplicity, which may properly claim a place in this connection. It is shown in section in Fig. 51 and from the end in Fig. 52.

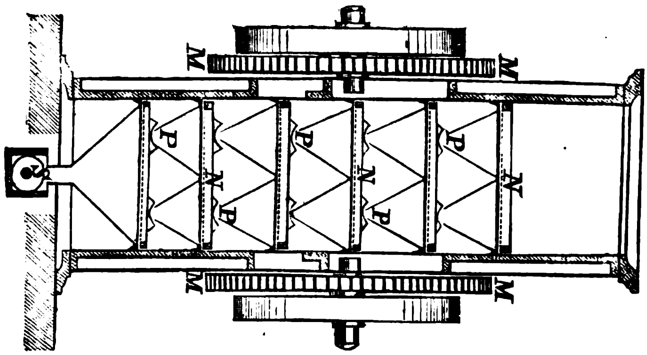


Fig. 52.

Fig. 53 exhibits a pair of cylinders one-twelfth of the actual size.

Fig. 53.

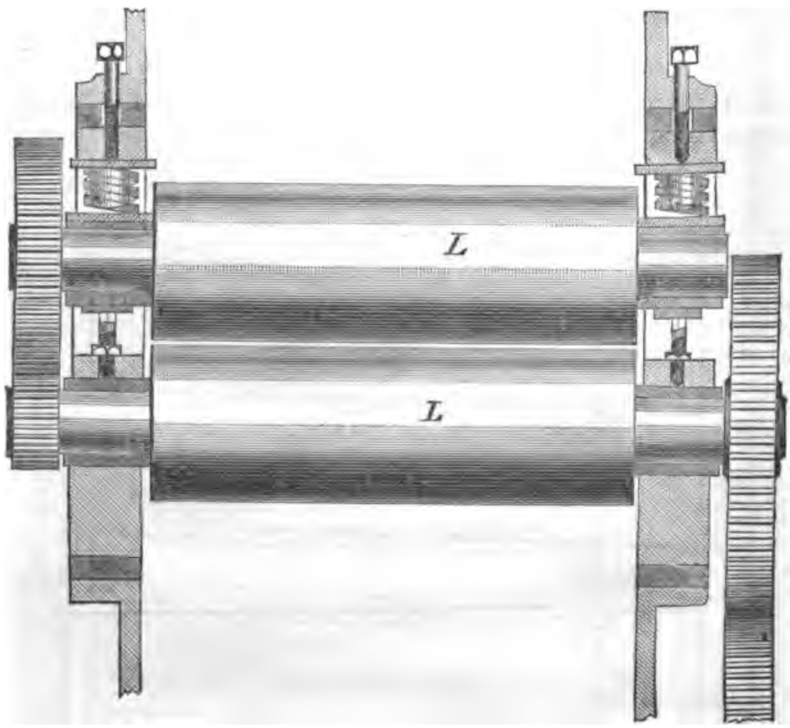
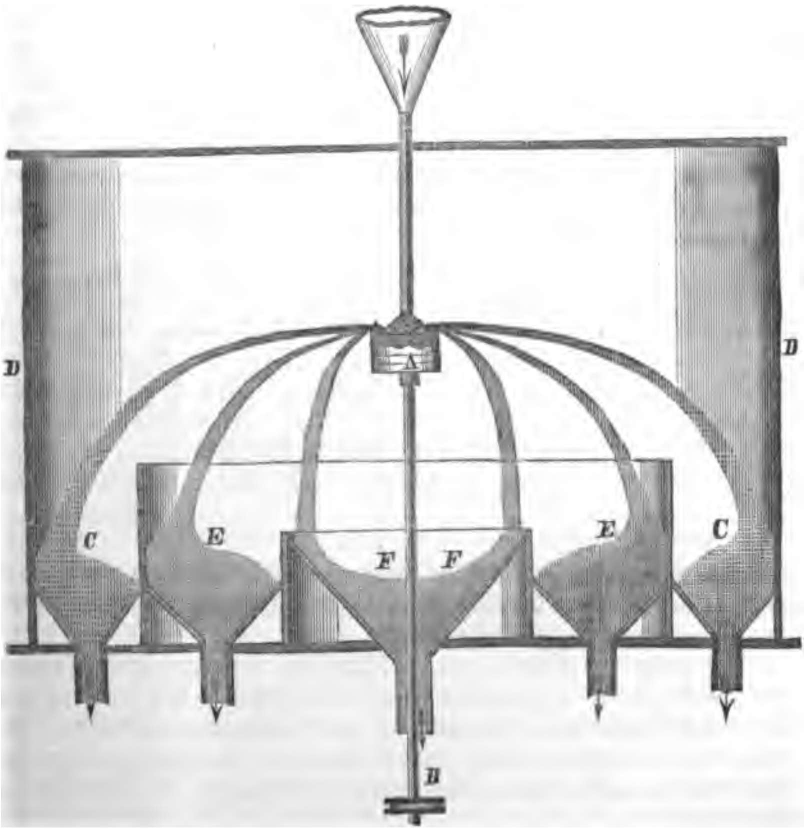


Fig. 54 is a centrifugal apparatus for grading the grits after the separation of the fine flour by the process of bolting.

The cylinders revolve with unequal velocity, and are all set in motion by a single large cog-wheel, M M. The pointed and purified grain is fed in between the highest pair of rollers L L, to be cracked as it passes

through into coarse fragments, and more or less flour, grits, and bran, which are received upon the inclined shaking-sieve N, where they are sorted; the grits and fine flour passing through to the trough P, to be discharged into the upright receiver R. The groats and bran pass on to the next pair of rollers, to be further reduced to finer groats, grits, flour, and bran. Falling upon the second sieve, the flour and grits pass through to the trough P, while the bran and groats pass on to the next pair of rollers, and so on until the groats having been reduced to grits and flour, all the bran is collected in T T, and all the flour and grits in S S. The screw conducts the flour and grits to a bolt, where the flour is bolted off, and the remaining grits graded in the centrifugal machine shown in Fig. 54.

Fig. 54.



134. The average production of the Hungarian mills on exhibition at the International Exposition at Vienna gave, according to the report of van den Wyngaert and Dr. Thiel, jurors from the German empire, the following results:

	Per cent.
Flour No. 0	6.2
Flour No. 1	7.8
Flour No. 2	6.3
Flour No. 3	5.0
Flour No. 4	5.0
Flour No. 5	5.0
Flour No. 6	16.5
Flour No. 7	11.9
Flour No. 8	9.4
Flour No. 9	2.2
Fine bran	9.1
Coarse bran	11.2
Chicken-feed	0.4
Dirt and vapor	4.0
	100.0

135. THE LOW MILLING.—The following table presents the results obtained by the low-milling process in North Germany, submitted for comparison at the Exposition:

Name of the product.	1		2		3	
	Per cent.		*Per cent.*		*Per cent.*	
Flour No. 0	65.0		65.0		75.05	
Flour No. 1	6.0	74	8.0	80	4.90	79.95
Flour No. 2	3.0		7.0		.00	
Pollen flour	2.5		.....		.....	
Coarse or groats bran	3.0	21	.....	18	6.70	17.85
Fine bran	......		12.5		.....	
Coarse bran, with hull	15.5		5.5		11.15	
Loss	5.0		2.0		2.20	

The following table exhibits the average results of the high-milling process as obtained from wheat of high order of excellence (from 86 to 87 pounds per metze) in the Vienna mills:

	Per cent.
Flour No. 0	4
Flour No. 1	20
Flour No. 2	10
Flour No. 3	12
Flour No. 4	12
Flour No. 5	12
Flour No. 6	6
Offal, (bran)	20
Dust	4

As contrasted with this, the high-milling process yielded to C. Genz, Heidelberg, the following products:

	Per cent.
Flour No. 0	25.5
Flour No. 1	15.5
Flour No. 2	5.0
Flour No. 3	25.0
Flour No. 4	3.5
Flour No. 5	1.5
Flour No. 6	1.5
Fine bran	11.0
Coarse bran	8.0
Cockle	0.5
Waste and loss	3.0

And the following were obtained by C. Hedrich, in Glauchau, Saxony:

	Per cent.
Extra imperial flour	23.3
Flour No. 00	5.6
Flour No. 0	5.8
Flour No. 1	8.3
Flour No. 2	11.2
Flour No. 3	15.0
Overflow	2.1
Groats bran	0.8
Fine bran	8.0
Coarse bran	10.1
Clippings bran	1.7
Waste	3.9
Vapor and loss	4.2

136. In view of the foregoing tables of results, the necessity of a congress of millers for the purpose of devising, for universal adoption, systems of numbers qualifying the grades of flour, each number having a definite qualitative signification, is self-evident. The numbers in each system of milling, high, half-high, or low, should manifestly admit of simplification and greater precision of meaning.

137. Without attempting to go further into the practical details of the high-milling processes as practiced in Austro-Hungary, we may see that the object to be gained in the alternate slow reduction of the grain and its grading and cleaning is to effect the utmost possible separation of the bran, the objectionable colored part of the grain, from the white interior, and to effect this by so slight production of heat that no deterioration of flour will take place in the process. The flour produced by the high-milling process, as a necessary result of the numerous boltings and siftings, is again and again exposed to the air, and will have the

dryness due to the climate of the region. This will necessarily prolong the period during which, without artificial drying, it may be kept without deterioration.

138. AMERICAN IMPROVED MODES.—Within the last three or four years, great improvements have been made in the better class of American mills, including the purification of commercial wheat, the adoption of the principles of the half-high milling, the *Walzmühle* or cylinder grinding, and numerous improved devices for purifying the connell or middlings. A system introduced from France two or three years since, in which the rate of revolution of the stones is greatly reduced, is specially suited to our northwestern spring-wheat, and is said to increase the yield of merchantable flour by 8 per cent.

Our method of packing in barrels is commended by German writers, although the Hungarian flour is, in general, transported in sacks. As has already been mentioned, it does not require artificial drying in order to "keep," as would be required if the grains were moistened preliminary to grinding, or as the plump, white, softer berry of the less favorable climates than that of Hungary makes necessary.

139. The flour that has uniformly stood first in our eastern markets, certainly until within a very few years, was the so-called southern flour. The wheat from which it was made was southern wheat, and was earlier in the market. The kernel was flinty and slightly shrunken. Some brands could be shipped with safety on long voyages. One of the best in repute was packed in barrels, hot, as it came from the bolt, while other flour, in the best class of mills, was uniformly cooled in the open air before packing. The brand that enjoyed this high repute, on analysis yielded at 212° Fahrenheit only 8 per cent. of water, while ordinary flours gave from 12 to 16 per cent. The latter became sour and musty when kept for long periods. The former experienced no deterioration. The reason is probably this: the heat consequent upon friction in grinding the choice brand had driven out from one-quarter to one-half of the water removable at 212° Fahrenheit; some of it water of hydration, from the gluten. This reduction in the quantity of water lessened the mobility of the molecules of the gluten, and with it, the capacity to undergo incipient fermentation. In this dried condition, the flour was packed in barrels, and the air and its moisture excluded. It was permitted to cool without opportunity to re-absorb moisture. In the case of ordinary flour, the cooling process of stirring in the open air, with the hopper-boy or its equivalent, gave opportunity for the water to be absorbed from the atmosphere. In the former case, the flour would keep for indefinitely long periods. In the latter case it would keep sweet but a comparatively short time. In the former case, the barrel of flour of 196 pounds, packed while hot, was the equivalent when fresh of from 204 to 212 pounds of flour packed after cooling in the open air. For immediate consumption, the difference in value was from 4 to 8 per

cent. in favor of the flour packed without cooling. For shipping purposes, the difference in value was of course much larger.

140. The appointments in some American mills are so complete as to enable the miller to extract the sound grains of wheat from the most varied mixtures with foreign seeds and impurities. For example, a sample of wheat obtained in the corn-market may contain sound wheat, sand, straw, stalks, chaff, oats, cockle, mustard, buckwheat, grass-seed, chess, corn, (maize,) blasted wheat.

141. This will be first passed through an inclined, revolving, cylindrical screen, having two grades of wire gauze. Through the first grade, the sand will escape. Through the second grade, all the remainder will drop except the corn, (maize,) and the larger bodies, like stalks and straw, which will go on to the tail of the screen.

The mass, freed from sand and the coarse matters, will then be fed in a thin cascade upon the jogging, inclined, perforated plates of the separator, already described, p. 22, which will remove the oats, chaff, and small fragments of straw on the one hand, and the mustard, cockle, grass-seed, and blasted wheat-grains on the other. Of these separators, a very inferior wheat would pass through three sets; then through three smut-machines with beaters, and a fourth provided with brushes; and then through a fourth separator, to remove the fine fragments, the headings and pointings produced in the smut-machines. Then follows a duster. Next the product of purified and pointed wheat passes to the run of stones, where a single grinding reduces the whole to meal. In the mill specially examined, the stones were 52 inches in diameter, having logarithmic, spiral furrows $\frac{3}{16}$ to $\frac{1}{4}$ of an inch deep, with finely-grooved, alternating lands of about equal area, the leading furrows running to the eye of the stone numbering 22, alternating with 22 short furrows running into the leading furrows. From the stones, the meal issues at a temperature of about 120° Fahrenheit, and is conducted to the bolts, where the first fine flour is separated from the remainder of bran, middlings, feed, tailings, &c., which are afterward graded by bolting.

142. The finer bran of the middlings, after passing through the middlings-purifier described on p. 52, goes into the "feed." The coarse bran goes to the bran-duster. The white interior, having been detached from the hulls, is conducted back to re-enter the whole meal on its way to the bolts. The middlings (grits) may be ground separately or discharged with the purified and pointed wheat directly into the run of stones.

The running stones make about 170 revolutions per minute; the bran-dusters, about 450 revolutions; and the smut-machines, about 500 in the same time.

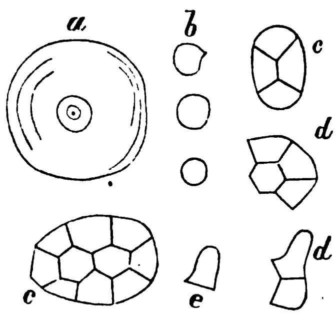
The above is an outline of the processes observed in Jewells Brothers' mills at Brooklyn, N. Y.

143. CHARACTERISTICS OF FLOUR.—The best wheat flour has a faint, pleasant aroma; is dry, heavy, by transmitted light having a light shade of clear brilliant-yellow, and readily balls in the hand. An inferior article, when pressed in the hand, shows a quality of adhesion, retaining the form imparted by the pressure.

Under the microscope, cells of larger and lesser size are readily recognized, and also the still lesser cells of albuminoid bodies, which, unlike the starch-cells, are not colored with iodine, and also portions of the frame-work of the cellular tissue of the interior, in which the starch and albuminoid cells are lodged.

144. Dr. Julius Wiesner, professor in the University of Vienna, of the international jury Group IV, in an elaborate paper upon the morphology of wheat-starch, recognizes three kinds of starch-granules, under the names of the lenticular, the small spherical or polyhedric, and the compound grains. The last variety had not been recognized by previous observers. They are found in the interior of the gluten-coat, and are made up of from two to twenty-five individual granules. These compound grains are rarely found in commercial starch, and seldom otherwise than in broken fragments. In admeasurements, the greater number of the grains showed two very unlike magnitudes, the one of the large lens-shaped, and the other of the smaller grain.

Fig. 55.



Compound lenticular starch-granules, (Wiesner.)

145. The accompanying diagram (Fig. 55) exhibits the different forms under a magnifying power of 1,000: *a*, the large lenticular simple starch-grain; *b*, the small simple starch-grain; *c c*, the compound starch-grain; *d d*, fragments of the compound starch-grain; *e*, the fragment of a twin starch-grain. The diameters of the large lenticular starch-grains are given in the following schedule:

Varieties.	Least diameter.	Greatest diameter.	Most frequent diameter.
	Millimeters.	*Millimeters.*	*Millimeters.*
Triticum vulgare (1)	0.0140	0.0390	0.0282
Triticum durum (2)	0.0110	0.0360	0.0261
Triticum turgidum (3)	0.0176	0.0411	0.0290
Triticum spelta (4)	0.0154	0.0396	0.0270
Triticum dicoccum (5)	0.0111	0.0301	0.0259
Triticum monococcum (6)	0.0120	0.0270	0.0195

(1) Twenty-three varieties from Mähren, Hungary, France, Italy, Chili, and Victoria (Australia) were examined.

(2) Six varieties from Mähren, Hungary, France, and Algiers.

(3) Fifteen varieties from Mähren, Lower Austria, Hungary, Switzerland, England, East India, Chili, and New South Wales.

(4) Four varieties from Würtemberg and Baden.

(5) Two varieties from the Vienna collection; origin unknown.

(6) Three varieties from the Vienna collection; origin unknown.

The same varieties of wheat that were employed in the determination of the magnitude of these granules served for the measure of the small starch-granules.

The small starch-granules gave the following magnitudes:

Varieties.	Least diameter.	Greatest diameter.	Most frequent diameter.
	Millimeters.	*Millimeters.*	*Millimeters.*
Triticum vulgare	0.0022	0.0082	0.0072
Triticum durum	0.0022	0.0078	0.0072
Triticum turgidum	0.0025	0.0082	0.0072
Triticum spelta	0.0025	0.0079	0.0070
Triticum dicoccum	0.0018	0.0068	0.0066
Triticum monococcum	0.0018	0.0060	0.0058

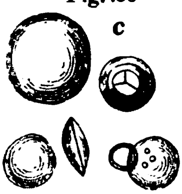
146. The compound starch-grains are found in the outer as well as inner layers of the gluten-coat; more frequently, however, in the inner layer. The quantity of these grains in comparison with the larger and lenticular grain is not large, the general form is elliptic or egg-shape, and they frequently exceed in size the large lenticular starch-grains. The largest of the compound grains measured by Dr. Wiesner had a diameter of 0.0324 millimeter. It is easy to distinguish under the microscope between wheat-starch and the various other starches in commerce, by their size, forms, and markings, with the exception of the starch of rye and of barley.

In Fig. 56 are rye-starch grains, magnified 750 times; and in the next figure, 57, we have the starch-grains of barley, magnified 750 times.

The difficulty arises from the circumstance that the starch-granules in the seed are found alike in the gluten-coat of the wheat, rye, and barley, and are of substantially the same size.

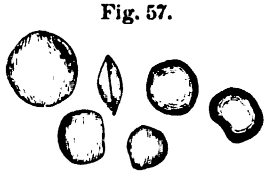
In the wheat-grain that has begun to grow, the starch-grains present the appearance given in the following diagram, (Fig. 58.)

Fig. .56



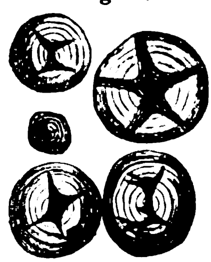
Rye starch-grain.

Fig. 57.



Barley-starch.

Fig. 58.



Starch-growing wheat.

Lesser fissures than those shown in the cut are also sometimes to be observed in the starch-grains of perfectly sound wheat.

147. GLUTEN-CELLS.—On page 4, we have a cross-section of the coats of the wheat upon a scale of four hundred diameters.

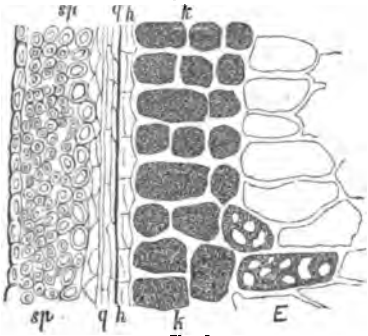
In the accompanying diagram, (59,) we have the ripe barley-grain on a cale of three hundred diameters. It will be remarked that the gluten-coat presents from two to three and even more layers of cells.

In the following figure, (60,) we have a section of the oat-grain.

In Fig. 61, we have a section of rice.

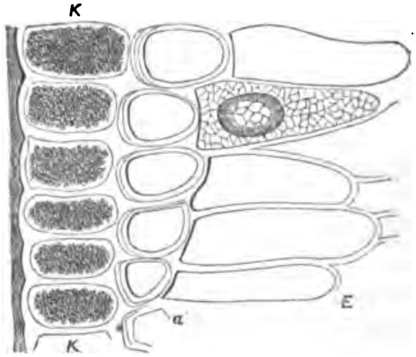
In Fig. 62, we have a section of Indian corn; and in Fig. 63, a section of rye.

Fig. 59.



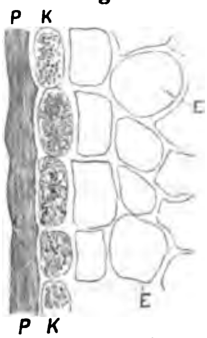
Barley.

Fig. 60.



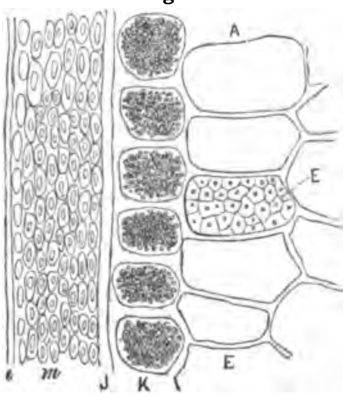
Oat.

Fig. 61.



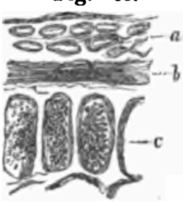
Rice.

Fig. 62.



Indian corn.

Fig. 63.



Rye.

148. Upon comparing these sections with each other, it will be seen that the structure of the different grains that have served from time immemorial as the material for the supply of farinaceous food of the world, has certain great distinguishing characteristics.

Within a series of layers of woody fiber, serving for the protection of the nutritious interior, and otherwise com aratively worthless, we have one or more layers of cells, containing the nitrogenous compounds and phosphatic salts, which serve the most important purposes of nutrition, as they largely furnish the materials for the various tissues of the human organism; and within these layers, to the center of the grain, a mass of starch-granules, larger and lesser, and cells containing albumi noids, supported in a loose frame-work of cellular tissue.

149. The art of milling in its perfection consists in the *disintegration*, not *destruction*, of these tissues and cells, and the removal from them of the woody fiber. This is more perfectly accomplished in the milling of the wheat than in that of any of the other grains, with perhaps the exception of the rice, and yields the whitest and to the palate the most acceptable flour.

150. HUNGARIAN PRIZE FLOUR.—In comparing the flours of the different countries with each other, the jury, in the first place, compared with each other the best 45 per cent. of the wheat of all the products of high milling; then all the products of half-high milling were compared together, and lastly the products of low milling.

The *average* of the products of the Hungarian mills with the high milling process stood (0 being perfection) 0.015. Of these, the flour of the Pesth *Walzmühle* held the first rank. The director of the mills, Herr Dosswald, received an imperial decoration. Of this flour, I obtained the complete series, including the grits and brans. The interest that attaches to this collection led me to make an analysis, which is herewith submitted.

151. By treating 0 flour with iodine, it is easy to make every large starch-granule blue, while all the minute grains (nitrogenous bodies) remain unchanged in color. Then, by treating another portion of flour with ammonio-nitrate of silver, the minute particles (nitrogenous bodies) will become yellow, while the starch-granules remain unchanged in color. This latter experiment proves at the same time the presence in the nitrogenous bodies of phosphoric acid, indeed of phosphates.

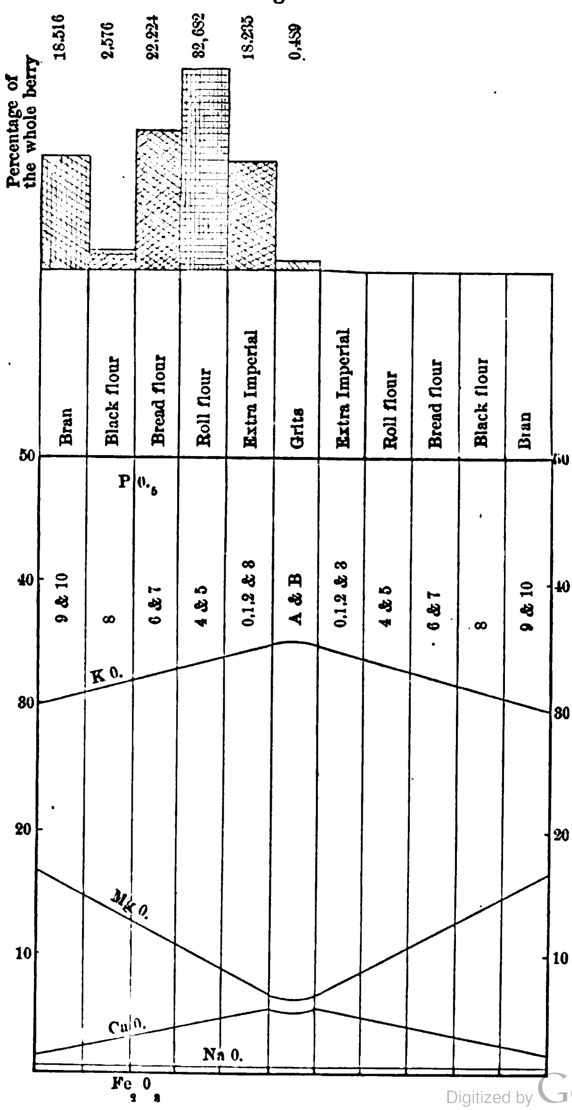
The No. 0 Hungarian flour has, under the microscope, a cleaner look, is freer from fine particles (of the albuminoid bodies?) than the product of low or half-high milling, as shown in the best grades of western flour in the Boston market. The mode of grading pursued at the Pesth mill would separate the finest particles; and as these are chiefly the little granules corresponding in appearance with those in the gluten-sacs of the inner shell, it is at once explained why the nitrogen should be less in the zero flour of Hungary.

		Water.	Ash.	Phosphoric acid.	Nitrogen.	Albuminoids, estimated from the nitrogen.
Grits	A	10.57	0.44	0.24	2.25	14.65
Imperial selection, or extra	No. 0	10.37	0.42	0.14	1.68	10.76
	No. 1	10.23	0.46	0.21	1.68	10.76
	No. 2	10.47	1.03	0.22	1.72	11.02
	No. 3	10.07	1.02	0.17	1.72	11.02
Semmel-flour, or roll-flour	No. 4	10.24	1.19	0.25	1.74	11.15
	No. 5	9.66	0.61	0.35	1.80	11.54
Bread-flour	No. 6	11.12	1.04	0.24	1.84	11.79
	No. 7	10.99	0.81	0.21	1.80	11.54
Black flour	No. 8	9.86	1.01	0.36	1.90	12.18
Fine bran	No. 9	9.71	7.32	2.96	1.98	12.69
Coarse bran	No. 10	11.01	4.21	1.74	2.21	14.16

152. These results will be intelligible if we understand that in the main the numbers may be regarded as qualifying the composition of the berry as one goes outward from the core to the surface of the unbranned or clipped grain. The grits are coarse fragments of the interior, carrying with them more or less of the gluten-coat, from which the true bran has been removed.

It will be remarked that the ash, or mineral portion, increases from the core to the surface; and that the phosphoric acid obeys the same law, though the rates are not the same. The nitrogen, as representing the total albuminoid bodies, also increases except in the grits, (A,) and in that the nitrogen is in marked excess.

Fig. 64.



153. Dempwolff made, at the instance of the late Baron Liebig, an elaborate analysis of the products of the Hungarian *Walzmühlen*, which I add in an appendix.

One of the striking results of Dempwolff's analysis I have illustrated in the foregoing cut, (Fig. 64.) He found the phosphoric acid to be about 50 per cent. of the ash in every part of the berry. The oxide of iron and the soda were each present in small quantity, and each in its constant percentage of the ash in all parts of the berry. The lime and potassa, however, increased from without inward—from the surface toward the core—while the magnesia diminished.

154. The cut also exhibits the relative total weights of the different products in percentages, indicated by volumes.

155. The white body of the interior of the berry is, for the most part, a mass of starch-grains of sizes, according to Prof. Julius Wiesner, ranging in diameter from 0.0110 to 0.0410 millimeter; or an average of about the one-thousandth of an inch. Embedded in this mass of starch are clusters of cells of a diameter ranging from 0.0022 to 0.0082 millimeter, or an average of two ten-thousandths of an inch in diameter, and containing nitrogen in their composition. These cells are the depositaries of the albuminoid bodies and the mineral constituents found in the interior of the berry. Among these smaller cells are also small starch-granules. On crushing a lump of the grits and placing it under a microscope, the starch-granules are seen surrounded by a great profusion of these albuminoid cells. As compared with No. 0 flour, the relative proportion of starch-granules in the latter is vastly greater. It would seem, therefore, that the cohesion of the mass in a lump of grits is a coincident fact, if it be not due largely, to the presence in it of the albuminoid bodies.

156. The composition of the 0 flour and the A grits is indicated in the following figures:

	A grits.	0 flour.
Ash	0.44	0.43
Phosphoric acid	0.24	0.14
Nitrogen	2.25	1.68

Occasional lumps of the grits are seen to have still adhering to them the gluten-coat, and even portions of the outer bran-coat. The presence of phosphoric acid in the minute grains of the interior of the grits may be readily shown by immersing the crushed grits in a solution of ammonio-nitrate of silver. The minute albuminoid cells become yellow, as already shown, from the formation of tribasic phosphate of silver, and are quite readily distinguished from the minute starch-grains.

157. In comparing this flour No. 0 with ordinary low-milled flour, under the microscope, one remarks a striking uniformity in size among the particles of the latter. One also remarks relatively very few broken or bruised starch-grains in the high-milled flour, while the reverse is true of the low-milled flour.

158. It would seem that the grits are due to the presence, in the particular mass of starch-grains and frame-work of cellular tissue, of some agglutinating material binding the grains and tissue together. Under the microscope, this material is seen in clusters of minute cells embedded in the mass of starch, and corresponding in size with the minute cells that fill the gluten-sacs. If a grits-fragment be moistened, and subjected to pressure upon a glass slide, and the upper thin glass plate be moved about, the tenacity and elasticity of the material of the albuminoid cells may be readily discerned. This is in keeping with the greater measure of gluten and the larger percentage of nitrogen in the grits as compared with that in the finer grades of flour.

This explanation of the nature and cause of the grits, as produced by the process of high or half-high milling, is in keeping with the climatic conditions which make a flinty wheat—that is, which cause a more rapid exhalation of moisture and an arrest of movement of the nitrogenous constituents toward the periphery of the berry. The flour-granules—that is, the finer portions resulting from abrasion of the grits—contain less gluten than the grits, for the obvious reason that, had they contained more gluten, they would have been less readily reduced to powder.

159. MODE OF TESTING FLOUR.—This belongs to the class of unwritten arts. To the inexperienced eye, all grades of flour, except the very worst, appear white, when each is examined by itself. When, however, several samples are placed side by side, and their surfaces made smooth by drawing over them lightly a polished spatula, they are seen to differ from each other in color, and especially if the samples be placed upon blue paper. The shade of yellowness will be seen to be due in some instances, as a magnifying-glass of moderate power will show, to minute particles of the interior bran still adhering to small grits; to fragments of the color-coat, especially the portion in the groove of the berry; or to fragments of the embryo. It may also be due to the actual color of the interior of some varieties of slightly-shrunken, hard, or flinty grain, which, when cut with a knife, presents, in the cross-section, a shade of pale reddish-yellow.

Any blue shade which the flour may present will be due to the minute fragments of the hulls of black foreign seeds, or possibly to particles of smut.

The feeling of grit in the flour, to be determined by rubbing between the thumb and finger, is one of the qualities in which flours from grains of unequal hardness differ from each other.

160. The aroma of the flour of recently-ground, fresh, sound grain is grateful to the sense of smell. But if the flour be old, and especially if it has not been adequately dried, or has been made from wheat "grown," or sprouted, in the shock, or has been subjected to excessive heat in the process of grinding, it will exhale products of fermentation that are more or less offensive.

161. If a small sample of flour be moistened with half its weight of water, and wrought into dough with the thumb and finger, it will exhibit the degree of tenacity and elasticity and a certain quality of liveliness, as it is termed, which causes it to return to its original form when extended or indented, upon which the baker depends to make his bread porous.

If the gluten, of which this tenacity is the normal property, be greatly deteriorated, the dough will "run," and the inferiority of the flour for those purposes which depend upon the tenacity and elasticity of the gluten will be proportioned substantially to the facility with which the dough "runs." This softening of the gluten points to rusted wheat, or wheat grown upon fields richly manured with concentrated organic manures, or wheat deteriorated from the presence of foreign seeds, as those of wild onion, but more frequently to flour that has itself been heated, or flour produced from wheat that has been wet and not properly dried, or grown in the field after harvesting and before housing.

162. The *chemical examination* consumes more time, but also determines certain points of importance which can be ascertained in no other way. The percentage determination of the nitrogen has been shown, by the researches of Krocker and Horsford, (Liebig's *Annalen*,) to be sufficient to determine at once with great precision the percentage, on the one hand of the gluten and associated albuminoid bodies, and on the other the starch with its small quantities of dextrine and sugar. The determination of the ash by burning, points at once to the percentage of nutritive mineral matter, as the phosphates for example; and the deter mination of the water which may be driven out at 212° points to the susceptibility of the flour to spontaneous deterioration. The larger the percentage of moisture present the less likely is the wheat to keep. The determination of the starch and gluten by subjecting a weighed quantity of flour moistened and fashioned into a ball of dough to a slender stream of water will yield a trustworthy result for the starch, but only for the gluten of perfectly sound flour; and even in that the vegetable albumen, caseine, and cerealine of Mégé Mouriès will be more or less dissolved and lost.

163. The whole of the nitrogenous bodies may be separated from the starch by treatment with diluted acetic acid, and, after the settling-out of the starch, the determination of the specific gravity of the solution will give the amount of the nitrogenous constituents.

HUNGARIAN MILL INDUSTRIES.

164. In the pamphlet accompanying the collective exhibition of the product of milling of Buda-Pesth and the cities of five Hungarian provinces, it is stated that the products of the wheat are exhibited in one kind of grits, nine sorts (No. 0–8) of flour, and two kinds of bran, (coarse and fine.) The Hungarian mill-industry is based in general on the total cereal production of the Hungarian kingdom, but especially

on the quality of the Hungarian wheat. Besides being rich in flour of extraordinary keeping quality, it contains more gluten than other varieties of wheat. The milling-art is so conducted that, taking advantage of every improvement in rendering it more perfect, the great excellencies of the raw material are rendered appreciable and brought into service. The Hungarian flour produced by high milling is, in the points of purity, whiteness, yield and keeping qualities, not equaled by that of any other country. Its keeping quality has been illustrated under trying circumstances—in transportation by sea under the equator, where for a whole year it has yielded from every 100 pounds of flour, 160 pounds of bread, of characteristic nutritive value and excellent taste. The mills of Buda-Pesth, for the most part erected or enlarged between 1865 and 1869, cost about $5,000,000. They contain 500 run of stones, and 168 *Walz* sets (of three pairs each) of steel rollers. They have a capacity of about 1,000,000,000 pounds of wheat per annum, valued at $37,000,000.

The mills of the provinces erected between 1862 and 1872 cost about $1,250,000, have 128 run of stones, and grind about 200,000,000 pounds of grain, having a value of about $7,500,000.

165. The preceding discussion will have qualified us to appreciate the excellence of the material from which the renowned Vienna bread is made, and we proceed to the discussion of the preliminary steps to its production.

CHAPTER III.

MAKING YEAST BREAD.

166. **Bread.**—Bread in its widest signification comprehends all the forms of farinaceous food which have been subjected to the processes of the culinary art. It embraces, besides loaf-bread, rolls and biscuit, the cracker, the merely boiled dough, the griddle-cake, and the numerous fanciful forms of farinaceous confectionery. For the most part, when fitted for consumption as food, they have received a cellular structure, and are light. The practical advantage of this porosity is that when eaten the digestive fluids—the saliva and gastric juice—readily penetrate the mass and promptly perform their function. The objection to "heavy" bread is that its digestion is retarded, and that is because the digestive fluids come in contact only with the outside of comparatively large masses; the absence of cellular structure preventing their penetration to the interior.

167. The superior digestibility of porous bread was known to the ancients, but, because its preparation required the use of flour already in a state of fermentation and decay, which filled the mass with bubbles and was offensive to smell and taste, it was proscribed from sacred uses on account of its conceived *impurity*. For these uses unleavened bread, which was a sort of Graham wafer, was required. This was mainly a product obtained by heating to a baking temperature a thin layer of paste made of whole meal or cracked grains and water.

The term *bread*, in its more limited signification, is applied to porous loaves and rolls. If the product contain butter or sugar, or spices or perfumes, or fruit, it is pastry, cake, or confectionery rather than bread There are exceptions to this definition. The mixed rye and wheat bread of Austro-Hungary, and the inferior roll and *Semmel* bread have sometimes, to disguise the odor or taste, a few caraway-seeds.

168. To secure the cellular structure of the bread, it is necessary that the flour should have a constituent which, when moistened with water at common temperature, shall possess two of the properties of India rubber, tenacity and elasticity; and that these properties shall, in a great degree, be lost on subjecting the moistened flour or kneaded dough to a certain elevated temperature. This body which nature has provided in the cereals is gluten, and in wheat it is associated with a mass of starch of remarkable whiteness and purity, and yields, when properly prepared and the baking processes are properly conducted, a product

exceedingly grateful to the palate. This palatability in the best forms of bread is partly due to the changes wrought in the starch of the interior crumb, which is largely a mere physical, not a chemical, change, and the changes which take place in the starch and gluten of the exterior crust, due to incipient destructive distillation, or roasting, and partly to the absence of special or marked odor and taste in the bread as a whole.

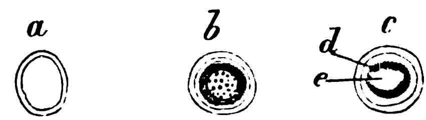
169. FERMENTATION.—The knowledge that whole meal wet with water will go into spontaneous fermentation must have been coeval with that of the first use of leavened bread. The philosophy of the changes which the flour undergoes in fermentation is of comparatively recent study and practical development. That a small portion of flour already in process of active fermentation would, when mixed with fresh flour and water, cause it to go into more prompt fermentation than when left to spontaneous change, must also have been known at an early period. Upon this was based the practice of setting apart a portion of the dough of each batch of bread to be employed in raising the succeeding batch, and this process prevails largely over the world at this day.

170. Pure starch mixed with water experiences no decomposition, but pure gluten mixed with water and set aside in a warm place, soon begins to swell from the production of gas-bubbles in its interior, and to exhale products at first grateful but at a later period offensive to the sense of smell, and from having had at the outset qualities of tenacity and elasticity, which permitted the formation and retention of gas-bubbles, it loses its tenacity in great degree, so that its bubbles escape from the larger volume, and the porous mass collapses to a smaller volume, and the material itself becomes semi-liquid. The changes it has experienced have given to the mass an acid reaction; it has become sour; various volatile products have been formed; the permanent fluid portions have taken on new composition and new qualities. If this mass be examined with a powerful microscope, it is found to contain, besides the materials furnished directly from the flour, numerous very minute bodies, of an irregular spherical form, which have been ascertained to be capable of carrying with themselves the capacity to produce fermentation when transferred to fresh mixtures of flour and water. These little bodies are the yeast-plant. They are the minute agencies of fermentation possessed by the sour dough. They are contained in countless myriads in a cent's worth of baker's yeast. They constitute the actual value in the brewer's and distiller's yeast. They are the principal bodies which are produced by following the various recipes for making potato-yeast, hop-yeast, bran-yeast, barm, &c. They are contained pure, with the exception of water, which constitutes from 70 to 80 per cent., in the moist German press-yeast cakes. It is estimated that a single cubic inch of the air-dried press-yeast contains some 1,200,000,000 of these minute organisms.

171. The researches of Dr. Julius Wiesner have shown that the fresh

yeast-cells (that is, cells taken from a fermenting fluid) are, for the most part, spherical or slightly elliptical, rarely oval, having an average greater diameter of 0.0087 millimeter. They are sacs, as shown in Fig. 65; *a* containing granules, as seen in *b*, and are, for the most part, filled with the jelly-like protoplasm, the center of which appears more transparent from the presence of a little air-cell, or vacuole, as indicated in *c*; *d* is the jelly, or protoplasm; and *e*, the thin space, or vacuole. The cells increase by budding.

Fig. 65.

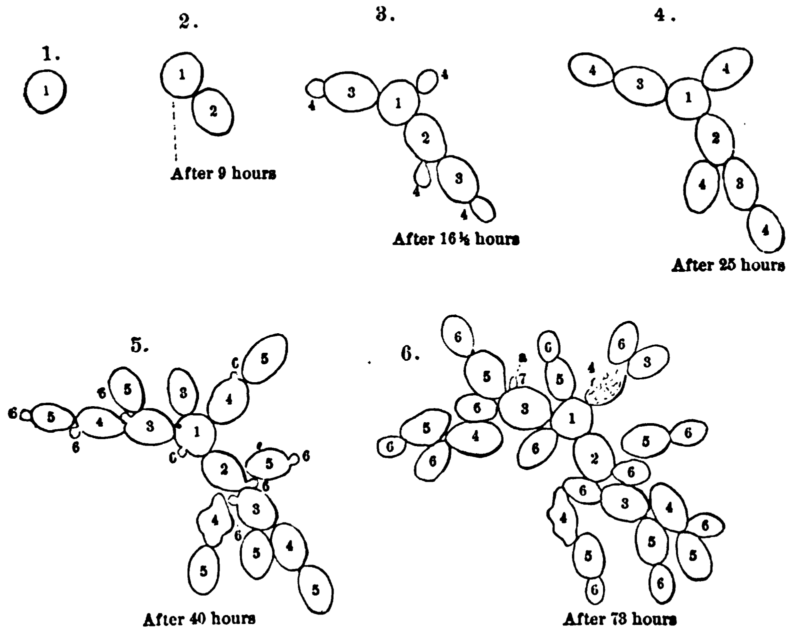


According to Pasteur, the young cells do not separate from the parent cells until they have attained to nearly the same size. According to other authors, including Mitscherlich, the yeast-cells also increase by bursting and diffusing their granular contents through the liquid; the granules then developing into cells.

172. Blondeau maintains that the young cells once separated always remain isolated, and never form branches, or elongated cells, like those that accompany lactic fermentation.

173. The following outline-diagrams (Fig. 66) illustrate the growth

Fig. 66.



of the yeast-plant from hour to hour, as observed under the microscope by Mitscherlich, (see vol. i, p. 372, Mitscherlich's *Lehrbuch*.)

The yeast-cells were taken from the malt-extract, placed between glass

plates, the edges of which were covered with melted wax to prevent evaporation, and kept at a temperature of about 66° Fahrenheit. The drawings were at intervals, as follows: 1, parent cell; 2, after 9 hours; 3, after 7½ hours more; 4, after 8½ hours more; 5, after 15 hours more; 6, after 33 hours more.

174. The younger cells not yet separated from the parent cells appear hyaline, crystalline, or extremely fine-grained. In perfectly-developed cells, one distinguishes readily the glassy, bluish plasma, (gelatinous contents of the cell,) and in the midst of it one or two, rarely three, reddish-appearing cavities having an average diameter half that of the cell. If these cells are transferred from a fermenting fluid into distilled water, they are observed immediately to swell with increase in size of their cavities. After a few days, they are enlarged to diameters occasionally as great as 0.138 millimeter; the cavities become enormously large, and sometimes fill the whole, and in elliptical cells extend from wall to wall bounding the shortest diameter. If, however, the yeast-cells are placed in a solution containing 20 per cent. or more of sugar, the cells lessen in size and by slow stages are reduced to one-half their original dimensions, and the cavities entirely disappear.

These experiments show that the cavities are increased by addition of water and reduced by its abstraction.

175. By drying the cells till they cease to lose weight—that is, first *in vacuo* and then in an air-bath at a temperature of from 230° to 248° Fahrenheit—they may be reduced to a diameter of from 0.0045 to 0.0068 millimeter, when the cavities will have entirely disappeared. They become shriveled and assume a yellowish tint. These dried cells will again take in water upon exposure with very great avidity. In a solution 10 to 15 per cent. strong of sugar, these cells become charged with numerous small reddish drops of water, having the appearance on a small scale of the larger cavities before mentioned.

Wiesner distinguishes between these cavities and the former ones as abnormal and normal cavities. The normal cavities are for the most part single, and seldom exceed three in number, while the abnormal are reddish, numerous, and spread about through the plasma of the cell.

176. Drying at a temperature of 212° Fahrenheit continued for several hours will not kill the yeast-plants, but all except the very youngest go over into the condition of abnormal cavities.

The young cells that have had no cavities will be the starting-point for fermentation, when yeast so dried is added to a solution of sugar.

The presence of numerous cavities is an evidence of impaired capacity for producing fermentation. The young undeveloped cells have no cavities except in very diluted solutions. The young full-grown cells have large cavities, and the old cells have the numerous small cavities. *All yeast-cells having cavities convert sugar into alcohol and carbonic acid.* Those having the abnormal cavities—that is, the numerous cavities—and those which have no cavities, having, first of all, either from age or any

other cause, passed through the stage preceding the formation of abnormal cavities, produce no fermentation; they are dead. The young cells, though without cavities, as they develop will acquire normal *cavities*, and then will produce alcoholic fermentation. Solutions containing only from 2 to 4 per cent. and from 20 to 25 per cent. of sugar, seem most favorable to the chemical and physical conditions of fermentation. In such solutions, the fermentation is complete. Solutions containing from 12 to 13 per cent. of sugar, or above 25 per cent. of sugar, do not undergo complete fermentation. The relations therefore of concentration and dilution of solution, influencing, by endosmosis and exosmosis, the condition of the contents of the cavities of the yeast-cells, determine the best circumstances for fermentation. The relative quantities of carbonic acid, alcohol, succinic acid, butyric acid, acetic acid, formic acid, lactic acid, and glycerine which arise in the process of fermentation are evidently dependent on the relations of the water to the protoplasm of the yeast-cells, and obviously also upon the percentage of sugar or concentration of the solution.

177. The following diagrams from Enyrim exhibit various appearances of the yeast-plants as observed by him.

Fig. 67.

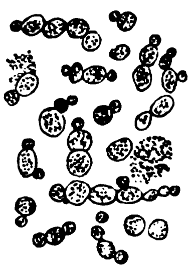


Fig. 68.

Fig. 69.

In Fig. 67, we have the appearance of yeast taken from mash, eight hours in fermentation, exhibiting the germs and the increase by budding and their union in the form of chains or threads.*

Fig. 68 exhibits the developed yeast-plant and the series of successive developments. In A, we have the cells with their cavities capable of

* They seem also to be charged with the abnormal cavities observed by Dr. Wiesner, and therefore incapable of alcoholic fermentation.

producing alcoholic fermentation; in B, we probably have the cells as observed by Dr. Wiesner, containing numerous abnormal cavities no longer capable of producing alcoholic fermentation; and in C, D, E, and F, probably the yeast-plant present with the lactic fermentation. Fig. 69, which is from the upper ferment of white-beer yeast magnified a thousand-fold, illustrates, in *a*, the parent cell, which in *b* is elongated, in *c* still more elongated, in *d* resolved into two adhering cells, the parent and the bud, and in *e* the young cell separated from the parent bud.

178. Dr. Hassall, well known from his researches on the subject of adulteration of food, has traced the yeast-plant, as he believes, successfully through these various stages of development.

Blondeau recognized the elongated or branch cells as connected with the *lactic* fermentation.

The weighty investigation of Dr. Wiesner has shown that the only forms of yeast-cells capable of producing alcohol and carbonic acid in solutions of sugar are the nearly round cells, which, in the observation of Pasteur, are produced by budding, and remain in contact with the parent cell, to be separated only when they have attained to nearly equal size, and thereafter, according to Blondeau, maintaining their isolated condition, and which have acquired normal cavities.

179. THE THEORY OF FERMENTATION.—The theory of fermentation is not yet settled. Pasteur, the advocate of the notion that the division of sugar into alcohol and carbonic acid is a concomitant of the vital processes of the yeast-plant, and, as a consequence, that the living yeast-cell is indispensably necessary for alcoholic fermentation, has the support of Helmholz since 1844.

Pasteur has shown that if the spores of the yeast-plant (*Penicilium glaucum* or *Mycoderma vini*) be sown on the surface of a fermentable liquid, having taken care to exclude all other germs, the fungus grows and develops on the *surface* an air-plant, absorbing oxygen from the air, and giving off carbonic acid, without the production of alcohol. If the liquid be agitated, and the film submerged, for a time there is no further change; but if the proper temperature be maintained, after a while bubbles of carbonic acid are given off, and the liquid yields alcohol on distillation. According to Pasteur, whether the yeast-plant shall occasion putrefaction or vinous fermentation in a fermentable liquid—such as a solution of sugar—depends on whether the growth takes place in the air at the surface of the liquid, or within the liquid below the surface.*

* Pasteur cites the following experiment: "If we half fill a flask with a fermentable liquid, such as a solution of sugar, and, having taken care to exclude all other germs, sow on its surface some spores of *Mycoderma vini* or *Penicilium glaucum*, the fungus grows and flourishes on the surface, feeding on the organic matter in the solution, absorbing oxygen from the air, and throwing off carbonic-acid gas. In this case, no alcohol is produced. If we now shake the flask, the film of fungus sinks through the liquid, and for a time there is no further change; but, after resting a little, if the tem-

180. A ferment is a living body, which is special in this respect, that it is capable of performing the functions of its life apart from *free* oxygen; it can assimilate directly oxygenated matters, such as sugar, and derive from them the requisite amount of heat; and it further can produce the decomposition of a much greater weight of fermentable matter than the weight of the ferment in action. Pasteur has found that ferments, such as yeast, lose their fermenting power—that is to say, the amount of organic matter decomposed diminishes and approaches the weight of the ferment employed—exactly in proportion to the amount of the oxygen supplied.

181. Pasteur claims to have shown, and this is one of the most curious results of his investigations, that the same fungus does not incite or maintain the alcoholic, the acetic-acid, the lactic-acid, or the butyric-acid fermentations, but that these changes are produced by different species, nearly allied but distinguishable from one another under the microscope; the specific differences between them extending to this strange difference in their powers of nutrition or respiration, which induces different reactions in a fermentable fluid.* This may be said to have become perhaps the more prevailing opinion of the men of science of the day.

Baron Liebig, so recently lost to science and the world, was the great defender of the opposite view, that the division of sugar into alcohol and carbonic acid was a phenomenon belonging to a numerous class in chemistry, where compound bodies in a state of comparatively unstable equilibrium are resolved into simpler groups by taking on the motion of other bodies in contact with them and in the condition of motion, and experiencing the molecular movements attendant upon this particular kind of motion.

One of the most recent researches upon this subject is by Manassein, of St. Petersburg, under the direction of Dr. Wiesner, made in 1871. The result of his research is embodied in the following sentence: "*Upon the basis of all these experiments, I consider myself justified in maintaining that the living yeast-cell is not necessary to alcoholic fermentation.*" He adds, "*It is more than probable that the specific ferment in the living yeast-cell, and in some varieties of mold, is produced as the emulsion is in sweet almonds.*" It is well known that this emulsion produces fermentation without any instrumentality of organic forms.

182. Still more recent researches have shown that alcoholic fermentation attends the growth of several genera and numerous species of yeast-plants, from which it is plain that alcoholic fermentation is a phe-

perature be kept up, bubbles of carbonic-acid gas begin to rise from the fungus, which continues to grow, although more slowly. Fermentation sets in instead of putrefaction, and alcohol is produced in sensible quantities. The one great change which has been produced in the circumstances of the fungus is that it has now been almost wholly excluded from contact with free oxygen, while, in its former condition, it was bathed in it." Upon this change, according to Pasteur, depends its now acting as a ferment instead of inducing putrefaction.

* Nature, p. 80, 1872.—Address by Wyville Thompson.

nomenon attendant on a peculiar molecular condition which many microscopic plants pass through. Liebig always maintained that this was a dynamic condition, not necessarily connected with growth or vitality.

This conclusion is supported by the startling discovery, made by Pasteur himself as well as by Lechartier and Bellamy, that sound fruits containing sugar, brought into an atmosphere free from oxygen, begin to produce carbonic acid and alcohol without the instrumentality of the fermentation of yeast. Pasteur held, in 1861, that oxygen is necessary to the growth of the yeast-plant. If the oxygen is present as such, or free, the plant consumes it, and partly assimilates the sugar and partly burns it. If the oxygen be not free, it is taken from the sugar. This view is not sustained by other and more recent researches.

183. O. Brefeld gives (in Wagner's *Repertorium*, 1873,) the following results of an investigation of the subject of alcoholic fermentation :

1. The alcohol-ferment requires, like all plants, for its development as a vegetable, the action of free oxygen.

2. In the exclusion of the air—the exclusion of free oxygen—the yeast-plant cannot grow.

3. It is a mistake to assume that the yeast-plant instead of free oxygen can take to its growth and increase combined oxygen from a body rich in this ingredient, like sugar, for example.

4. Again, it is a mistake that upon this accredited peculiarity of ferment to vegetate—to grow upon combined oxygen—the process of fermentation depends.

5. The alcoholic fermentation is excited by living yeast-cells that are shut off from free oxygen and do not grow.

6. The fermentation is in this case the expression of an abnormal, imperfect, vital process, in which the necessary material to the growth of the yeast-plant—the sugar, nitrogenous and mineral substances, and free oxygen—do not all work together to the simultaneous and harmonious growth of the yeast. The sugar by itself, or in mistaken relations to the other nutrient substances, will be decomposed and separated by the yeast-cells.

The yeast-cell which possesses the power in this abnormal vital process will show enfeebling of its vitality to continue for weeks.

7. The yeast-cell has great affinity for free oxygen; it possesses the power to grow in carbonic acid that contains less than $\frac{1}{6000}$ of its volume of free oxygen, and perfectly consume the whole of the oxygen. This affinity for free oxygen is not possessed by the lower types of mold, with the exception of *Mucor racemosus* and the nearest related organisms. The yeast-plant is, by reason of this property, an extremely fine reagent for oxygen.

8. By reason of the strong affinity of the yeast-plant for oxygen, united with its peculiarity of living in fluids, and rapidly to multiply and grow, there comes in fluid media, in which the yeast-plant grows, a *dearth of free oxygen*, and with it the phenomenon of fermentation, as, for example, in the art of beer-brewing.

9. There may arise in a fluid, fermentation and growth of the yeast-plant at the same time, even when the surface is in direct contact with the free air. Neither from a theoretical nor from a practical standpoint is the possibility shut out that fermentation and growth may both take place at the same instant in a yeast-cell; that, therefore, the growing yeast-cell which is in inharmonious relations to the free oxygen present may ferment the sugar it has absorbed.

184. Effects of fermentation.—The action of the acids of ferment is well known. They tend to liquefy the gluten, and deprive it of its tenacity and elasticity. [With time, gluten dissolves in acetic acid; this being the foundation of one of the methods of determining the amount of gluten in the flour. The gluten is dissolved away from the starch; the starch weighed by itself; and the gluten determined, as we have seen, from the specific gravity of the solution.] It is also well known that dough too far advanced in fermentation (old leaven) yields offensive products both to the taste and smell, including butyric ether and other offensive products.

185. Why Hungarian flour will make light bread.—We are now able to see how the superiority of the Hungarian flour produced by the high-milling process is intimately connected with the production of the Vienna bread, which is entirely free from acidity and any offensive odor. The gluten encased in its cells, not having been crushed, is but slightly exposed to the action of the press-yeast. The press-yeast is capable of converting the starch into sugar, and sugar into alcohol and carbonic acid. The nitrogenous constituents, owing to their protection within cells, largely retain the integrity of their chemical constitution. The tendency to lactic fermentation, where portions of the gluten are in solution, and, as a consequence, of the acidity degrading or liquefying the gluten and so making the bread heavy and sour, or of butyric acid and other compounds, offensive to the taste and smell, would manifestly be increased by the rupture of the gluten-cells, which is produced in much larger measure in the process of low milling.

Why bread made from oat, rye, or barley meal is heavy.—We have hitherto spoken of gluten as the body upon the tenacity and elasticity of which the capacity of the moistened flour to hold gas-bubbles depends. Strictly speaking, this quality is due to a portion only of the body separated from the starch of flour by washing with water. The body so obtained, on treatment with alcohol, is resolved, as already pointed out, into two substances; one soluble and the other insoluble in alcohol. Of the portion soluble in alcohol, there are two, one called mucine—vegetable caseine, and the other called glutin, or glyadin, or vegetable gelatine. It is to this vegetable gelatine that the capacity to hold gas-bubbles is due, and it is because wheat contains a notable portion of it that this grain will yield a highly porous bread, and other cereal grains, oats, rye and barley, for example, which contain only traces of vegetable gelatine, yield only heavy bread or bread deficient in porosity. It is this vege-

table gelatine, the degradation of which by acids produced in fermentation, and so causing a diminution of its tenacity, that deprives the walls of the cells in the sponge of their cohesion and allows it to collapse. It is in consequence of this liquefaction of the vegetable gelatine that flour which has from any cause become sour is no longer capable of making a light or highly cellular bread.

186. To counteract this deterioration, Liebig proposed the use of lime-water, which arrests the liquefaction of the vegetable gelatine, and by some kind of combination restores more or less its tenacity. Ritthausen found that solution of sulphate of lime possessed the property of increasing the tenacity of gluten, and so facilitated its separation from the starch of flour by the process of washing. The same end is effected with inferior flours by the employment of small quantities of alum in solution in making the dough, and also in the use of small quantities of sulphate of copper and sulphate of zinc. All these agents have the effect of increasing the whiteness of the bread produced over that which would be produced by the simple process of fermentation. Mégé Mouriès conceives that the darkening of the dough, which sometimes occurs even in the use of white flour, is due to an excess of lactic fermentation produced by cerealine, the nitrogenous constituent soluble in water which he finds in the gluten-coat. This action which produces at first proportionally more dextrine, at a later period yields, at the expense of the gluten, ammonia and a brown substance. It is to the predominance of this ferment in the dough of black bread that its extreme dark color is to be ascribed. The presence of acetic and butyric or lactic acid is objectionable, because it tends to liquefy the gluten and make the bread heavy and sour to the taste; so also any offensive gases or ethers, such as accompany putrefactive fermentation; so also the degradation of color.

187. PROBLEM OF A BREAD YEAST.—It will be seen from the foregoing that the problem of a bread-yeast is the production of a yeast-plant capable, within a limited time, of producing *only* alcohol and carbonic acid; the alcohol by itself producing comparatively little effect upon the dough, and the carbonic acid serving only by its production of cellules or pores, in every part of the interior of the mass of dough, to give the bread lightness. Such a yeast was the ideal yeast sought by the Vienna bakers, and for which they offered their prize, won by Mautner, of St. Marks, Austria.

188. THE PRESS-YEAST.—Historically, the press-yeast dates back to 1847 and the introduction of the yeast from beer, only to 1817. Up to that time, the sour dough, and a mixture of sour dough and hops obtained by boiling, were the instrumentalities for producing porous bread throughout Austria and Southern Europe. At this time in Vienna there was introduced by the bakers a roll made with a finer quality of flour by the process of *sweet fermentation*, (that is, with yeast,) which was called the imperial roll, (*Kaiser-Semmel.*) From this time to 1840, nothing new appeared, though there was constant demand for the sweet fermented rolls.

At length, a prize was offered in 1845 by the Association of Vienna Bakers, (an association which has kept its records from the year 1452 down,) for the independent production of a good yeast, and the trades-union recognizing the importance of the object, offered to the discoverer the loan of its great gold medal. The offer of these prizes met with success in 1847. Adolf Ignaz Mautner, succeeded in producing the desired article, and in 1850 the prize and the medal were awarded for the production of his cereal press-yeast. From this point on, the baking-industry made rapid development throughout the Austrian empire, and at the Paris Exposition in 1867 the Vienna bakery was recognized as the first in the world. Vienna may therefore properly claim the double honor of having been the seat of the first development of the art of high milling and the birthplace of the use of press-yeast.

189. To give some idea of the development of this industry, the press yeast sold by A. I. Mautner & Son is herewith presented:

	Zollverein pounds
1846	72,400
1852	380,600
1862	1,144,500
1872	3,170,000

In recognition of the magnitude and importance of this branch of industry, the council of the international jury of 1873 gave to this firm the Grand diploma of Honor.

190. Preparation of the press-yeast.—The press-yeast is obtained by skimming the froth from the mash in active fermentation, which contains the upper yeast, and repeatedly washing it with cold water until only the pure white yeast settles clear from the water. This soft, tenacious mass, after the water has been drawn off, is gathered into bags and subjected to hydraulic pressure until there remains a semi-solid, somewhat brittle, dough-like substance, still containing 80 per cent. of water. This is the *press-yeast.* It is then resolved into packages of definite weight up to four pounds, and wrapped in paper, and supplied to the market. Such yeast in summer will keep for eight days, and for an indefinite time on ice.

191. There are several modes of producing the press-yeast. The writer visited the press-yeast manufactory of the Brothers Rheininghaus at Steinfeld, near Graz, Steyermark, which is upon a large scale, and the products of which attracted especial attention at the Exposition. In this establishment, both beer and alcohol are produced. In the preparation of the press-yeast, coarse rye-meal is preferred. The wheat-groats are less suited, probably because the excess of gluten interferes with the removal of the water by pressure. Potatoes can be employed, but the yeast produced is not so effective or lasting. Malt is employed to produce sugar. One part is enough for the perfect mashing of eighteen parts of flour. The mashing has for its office the conversion of starch into sugar. This takes place best at a temperature of 140° to 145° Fah-

renheit. In from two to six hours, the conversion into sugar is complete, which may be recognized by the sweet taste.

This solution is cooled to a temperature of from 75° to 80° Fahrenheit, and then active yeast should be added at the same temperature, stirred intimately, and left at a temperature of about 75°.

To facilitate the rising of the yeast-cells, an alkaline carbonate and diluted sulphuric acid are added. To every 100 pounds of the flour, half an ounce of oil of vitriol (HO, SO_3) diluted with water and its equivalent of bicarbonate of soda are employed.

The disengaged carbonic-acid gas in rising to the surface carries the yeast-cells up with it. The foam that rises to the surface is skimmed off and repeatedly washed with water. The water is drawn off from the yeast-cells that settle out at the bottom, and the white deposit gathered in cloth bags, and the excess of water removed by pressure.

192. Xavier Zettler, of Munich, employs a mixture of equal parts of rye-malt, unground wheat, and slowly roasted barley-malt. These three are intimately and finely ground together, and to this mixture 4 to 5 per cent. of steamed and dried finely-ground potatoes are added. These are made into a mash with water at a temperature of about 145° to 150° Fahrenheit; then sufficient water is added to make it into a uniform emulsion, which will carry the temperature down to 120°. To bring it back to the temperature for the production of sugar, (from 140° to 150°,) water of a temperature of 200° is added with constant stirring. The mash remains now from twenty to twenty-four hours, during which the lactic acid produced liquefies the gluten. When this has taken place, which prepares the mash for rapid fermentation, the emulsion is rapidly cooled by the addition of cold water and the employment of a cooling-apparatus to the temperature of 75° to 80°, and the yeast added in the proportion of four parts yeast to a hundred of the malt-mixture. This mixture is stirred up in fresh water, and added to a small quantity of the mash in a separate vessel, in which the fermentation proceeds rapidly. When it has attained its highest activity, it will be returned to the whole mass. This now remains ten to twelve hours, during which the perfect fermentation will have commenced, and the whole mass have gone over to the period of the production of yeast-cells. When this period has closed, which will be indicated by the falling of the mash, the foam will be skimmed off, repeatedly mashed in fresh water, permitted to settle out, collected, and pressed.

The details of the processes pursued in the establishment of Rheininghans, at Steinfeld, and of Mautner & Son, in St. Marks, I am not in position to communicate.

Before proceeding to the description of the use of the press-yeast, it may be well to glance at the other processes of making bread in use in Germany and France, which have gained a place among the bakers of those countries.

193. The PUMPERNICKEL OF WESTPHALIA, which is made from whole

rye-meal, and which is substantially the black bread produced by slow baking in large loaves, and used among the lower classes, and in the armies of Eastern Europe, is *usually* made without the use of yeast, employing only the leaven or dough of the previous batch to secure the desired porosity.

The ordinary bread of rye-flour, or of mixed wheat and rye, made in loaves, and so extensively in use in Germany and Austria among the peasant classes, and also among the higher classes, because of its greater nutritive value than the bread made from the higher grades of wheat-flour, is now generally made with the aid of yeast.

194. PARIS WHEAT-BREAD.—In Paris, the wheat-bread is produced in the following manner: The fermentation is made to depend chiefly upon the gluten of the dough; yeast being employed merely to introduce and facilitate the action.

1. A lump of dough remaining from the last batch of bread, consisting of 8 pounds of flour and 4 pounds of water, 12 pounds, is set aside at eight o'clock in the evening. This is left till the next morning at six o'clock, and constitutes the so-called fresh leaven.

2. This is then kneaded with 8 pounds of meal and 4 pounds of water, which gives the once revived leaven, 12 pounds.

3. At two o'clock in the afternoon, the baker kneads in 16 pounds of flour and 8 pounds of water, and this gives the second revived leaven, 24 pounds.

4. At five o'clock in the afternoon, he adds 100 pounds of flour and 52 pounds of water, to which from two to three tenths of a pound of yeast have been added, making 152.2 pounds, and altogether, of dough, 200 pounds.

5. At seven o'clock in the evening, he adds to this dough 132 pounds of flour and 68 pounds of water, with from three to six tenths of a pound of yeast and 2 pounds of salt, and kneads the whole to a mass of dough, which weighs altogether about 402 pounds.

From this portion of dough, he makes five batches of bread in the following way:

First baking: He takes half of the dough, fashions it into loaves of the proper size and form, sets it aside for a while at a temperature of 70° Fahrenheit to rise, and then puts it in the oven to bake. The bread so obtained has a sour taste and dark color.

Second baking: The half of the remaining dough is mixed with 132 pounds of flour and about 68 pounds of water, from three to six tenths of a pound of yeast and 2 pounds of salt, and the whole immediately kneaded. Half of this product is taken for the second baking. It is whiter and better than the first baking.

Third baking: The remaining half of the dough left from the second baking is mixed with 132 pounds of flour and 68 pounds of water, containing three-tenths of a pound of yeast and two pounds of salt, and the whole immediately kneaded. The third baking is made from the half of the so prepared dough.

The fourth baking is prepared like the third.

Fifth baking: This is prepared as the preceding, and yields fancy bread, the finest quality produced.

195. MÉGÉ MOURIÈS'S METHOD.—Mégé Mouriès has sought to introduce an improved method of bread-making. It is bread resting upon a mode of grading the products of milling, so as to yield from 100 pounds of wheat—

72.72 pounds of flour and white groats;
15.72 pounds of brown groats;
11.56 pounds of bran.

At six o'clock in the evening, to 40 pounds of water, at a temperature of 70°, he adds the tenth of a pound of grape-sugar, and seven hundredths of a pound of yeast. This mixture he leaves over night at a temperature of 70°. At six o'clock the next morning, the fluid will be saturated with carbonic acid. He then stirs in the brown groats, 15.72 pounds, when the fermentation immediately begins. At two o'clock, he adds 30 pounds of water, and passes the mixture through a hair-sieve to separate the bran from the added groats. The mixture separated from the bran weighs about 55 pounds. To this he adds the 72.72 pounds of flour, and seven-tenths of a pound of salt, and kneads the whole to a dough. The dough will be fashioned into loaves, in which the fermentation will go on, and then placed in the oven to be baked.

196. By this process, Mégé Mouriès uses the 72.72 pounds of white flour and about 12.72 pounds which come from the brown groats. This process, although promising a larger percentage of white bread from a given weight of wheat, does not seem to have met with extensive introduction.

197. The method accredited to the London bakers is the following: The process contemplates the consumption of a sack of flour weighing 280 pounds. For this flour, 5 or 6 pounds of boiled potatoes freed from their skins, rubbed with from 2 to 3 pounds of the flour and one quart of fluid beer-yeast, and then intimately stirred with sufficient water to make the whole a uniform thin emulsion. Fermentation commences almost immediately, and after three hours the ferment may be used. It is at its maximum in about four or five hours. To this, 20 pounds of water are added, and the flour worked in till a stiff dough is formed. This is set in a warm place to ferment. At the end of an hour, the *bubbles* begin to swell the mass, soon the carbonic-acid gas escapes, and the dough falls. Soon after a second accumulation of gas-bubbles takes place and escapes.

The next operation consists in diffusing this dough in water, making about 150 pounds in all, adding to this uniform emulsion 2 to 4 pounds of salt, according to taste, and then working in the balance of the meal.

The dough is allowed to stand for 1½ or 2 hours, and then fashioned into 4¼-pound loaves, which are put into an oven of about 572° Fahrenheit at the beginning, which falls to from 400° to 430° in the hour of baking. This process yields 94 so-called 4-pound loaves.

These two methods are circumstantial to the last degree. The Vienna method, which rests upon the use of *press*-yeast, as will be seen, is much simpler.

198. Substitutes for Ferment.—The discovery that the essential thing to making bread porous was a spring of carbonic-acid gas in every part of the moistened flour was made elsewhere as well as in Germany. Fifty years ago, in this country, bread was made by employing, in the place of leaven, sour milk and bicarbonate of potash, (saleratus.) The acid of sour milk (lactic acid) united with the potassa of the carbonate, and, setting the carbonic acid free, gave porosity to the dough. Thirty years ago, cream tartar (the acid tartrate of potassa) was substituted for the sour milk, and bicarbonate of soda for bicarbonate ot potassa. The cream tartar had the advantage over sour milk that, being a powder, it could be weighed, and thus the proper proportion be taken to exactly neutralize the soda of the bicarbonate, also a powder, and invariably yield a white biscuit or bread. Besides this, the sour milk, varying in the proportion of its lactic acid, would, from its imperfectly neutralizing the soda, sometimes leave a portion of that constituent to discolor the product.

As a substitute for sour milk, diluted hydrochloric acid was employed in England, in the bread, with bicarbonate of soda, yielding common salt, which is a necessary constituent of farinaceous food. The attempt was made to saturate the dry flour with hydrochloric acid, so that the flour so prepared could, when required for use, be intimately mixed by sifting with another portion of flour, with which an equivalent of bicarbonate of soda had been intimately mixed, and then the whole stirred up with water and immediately baked.

Baron Liebig modified this process, adapting it to the whole meal of rye or wheat, with a view to the increase of the nutritive value, by preventing the loss consequent upon fermentation of the dark bread in use among the lower classes in Germany.

199. In England, tartaric acid, obtained from cream tartar, was mingled with its equivalent of bicarbonate of soda, and this mixture with flour, yielding what was called a *self-raising flour*. It required only the addition of milk or water, in proper proportion to make a dough, and this might be immediately introduced into the oven and baked. The tartaric acid and bicarbonate of soda promptly dissolving and reacting on each other in the water or milk, disengaged the carbonic acid, giving porosity to the dough, and with the baking the desired cellular structure of the bread.

200. Dauglish's method, aerated bread.—The method of making bread, invented and introduced into England by Dr. Dauglish, recognized that the essential quality of an agent for making the dough porous was a spring of carbonic acid in every part of the moistened flour, and carried out to practical working, the idea of mixing the flour in a confined space with water charged under pressure with carbonic acid, (soda-water.) The dough so formed, on coming to the

air of ordinary atmospheric pressure, expanded under the influence of the expanding carbonic acid until the whole possessed the cellular structure of thoroughly leavened dough, when it was immediately put into the oven and baked.

These various processes, like the yeast and leaven processes, contemplated no addition to the nutritive value of the bread.

201. PHOSPHATIC BREAD.—A process having in view increased nutritive value to the bread, which was exhibited at the Vienna Exhibition at the request of the Archduke Albert and the minister of war of the Austrian government, will be described in the appendix, under the head of phosphatic bread.

202. CHANGES OF FLOUR IN BECOMING BREAD.—In popular use, we employ the word "bread" to qualify loaves which are served in slices. The rolls are much smaller. Both consist alike of crumb and crust. The crumb is made up of a multitude of cells of thin walls containing carbonic-acid gas, the product of fermentation in the dough. These walls of the cells contain both gluten and starch and traces of dextrine and sugar. As a consequence of the treatment of water and the application of heat, the starch-grains, which, in their normal condition, are little sacs filled with minute granules of starch proper, have been swollen and burst. Starch similarly treated by itself, as in the preparation for stiffening linen in the laundry, when dried in a thin layer upon glass plate, for example, is transparent and presents a glazed surface. When this glazed material is removed with a knife-blade, it is seen to be stiff and horny. The gluten, which is mixed with it in the crumb of bread, and which may be conceived to be continuous, however thin throughout the wall of the cell, has been, by the process of baking, dehydrated; that is, the heat to which it has been subjected has driven out a certain amount of water, which chemically sustains something like the same relation to the gluten from which it has been expelled that the water expelled by heat from alum-crystals sustains to the original body of alum. This is the condition of the gluten from the crumb in the interior of the loaf at the instant of its removal from the oven. On drying, it abstracts the water from the starch with which it is coated, or intimately mixed, as the roasted alum absorbs the water that is sprinkled upon it. The starch by this process being dried and stiffened, gives its support to the walls of the cell, and renders the texture of the stale loaf more firm than that of the fresh loaf.

203. That the starch has undergone no especial change as the result of fermentation, beyond its conversion into glacial starch and the conversion of a certain small amount into dextrine or gum-sugar (glucose) and alcohol and carbonic-acid gas, is evident from the reaction which it gives with solution of iodine.

It has taken on a property, which we observe in the boiled starch of the laundry, of drying in thin layers to a transparent, horn-like varnish, less readily taken up by water.

The starch has also, in the mixing and kneading of the dough, become

incorporated with the gluten, so that after baking, when it has become the glassy starch, it is no longer possible to separate the gluten as a distinct elastic body, such as may be produced from flour.

The gluten has been to some extent consumed in the process of fermentation, more especially in that form of it discussed by Mégé Mouriès, where the bread is dark and sweet, and in which I have observed the presence of ammonia. In the alcoholic fermentation, the degradation of the gluten is less.

204. The examination of the crust shows that heat has produced a variety of effects of marked character. The application of the iodine test shows that the starch is no longer present. It has been converted into dextrine.* Portions of the dextrine, as well as of the gluten, have been subjected to slight destructive distillation, yielding at the outset, with proper temperature, an agreeable essential oil, the grateful aroma of warm, freshly-baked rolls. If continued too long, the destructive distillation produced causes the formation of substances less grateful to the sense of smell, bitter to the taste, and worthless for purposes of nutrition. Among the bodies thus produced, Reichenbach recognizes *assamar*, a bitter substance, the effects of which on the human organism, according to v. Bibra, are akin to those of coffee.

205. In large loaves of bread, the thickness of the unpalatable crust is sometimes nearly half an inch, and this is not unfrequently sacrificed where such bread is made for the use of armies in the field.

206. Another effect of baking, and which is one of the chief results, is the coagulation of the vegetable albumen, one of the nitrogenous constituents of the flour, which is soluble in water, and which, diffused over the walls of the cells, contributes to their rigidity, and unites with the tenacious vegetable gelatine and the glassy starch in preventing the cell-walls from easily giving way after the requisite temperature has been maintained a sufficient length of time.

207. The test for phosphoric acid in the crumb, ammonio-sulphate of copper, or, better, ammonio-nitrate of silver, will show that the phosphatic constituents of the flour, as a part of the nitrogenous constituents, are present in every part of all the cells of well-made bread, and, therefore, that portions of the albuminoid bodies have been dissolved in the water used in making the dough.

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* The baker is well aware of the presence of gum, or dextrine, in the crust. If, by chance, the just baked loaf, instead of being removed from the bake-pan, is allowed to remain in it, the vapor of water, escaping from the fresh loaf as a consequence of the elevated temperature, striking the tin, which has cooled from exposure to the air outside of the oven, is condensed to water between the tin and the loaf, and, dissolving the dextrine in the crust, makes the surface of the loaf below the margin of the bake-pan moist and sticky.

It is well known that thin slices of toast may be digested in a sensitive stomach without producing the distress occasioned by flatulency, and which, when fresh warm yeast-bread is eaten, is due to fermentation. The process of toasting has not only destroyed the yeast-germs, but it has converted the starch into dextrine, which is incapable of fermentation, and so of course incapable of producing flatulency.

208. The principal desirable effect of the heat in baking the bread, as we have seen, is, therefore, the coagulation of the albumen in the cell-walls, by which their permanency has largely been secured, to the advantage of the office of digestion and the destruction of the yeast-plant, as the cellular structure provides for the imbibition of the digestive fluids. The change wrought in the gluten is seen in the impossibility of obtaining it by any process of kneading and washing applied to the crumb of the loaf. We now see why it is necessary that the heat applied to the exterior of the loaf should be longer continued where the mass is large than where it is small; why small rolls may be baked in from ten to fifteen minutes with a temperature of 500° to 550° Fahrenheit, while a large loaf may require from one to three hours, according to the size. As the heat must be continued until the required change in the vegetable albumen has extended to the heart of the loaf, and as this takes time in proportion to the diameter of the loaf, we see why the surface may be burned before the interior is properly cooked; and, as a corollary, we see that the smaller the loaf the less change the surface will experience, the less injury it will receive during the time of its necessary stay in the oven to complete the cooking of the interior.

209. To prevent the burning of the crust, and yet produce loaves of considerable size, ovens are in use in Austria, and to some extent in this country, in which, until the mass of dough is thoroughly cooked, the loaf is surrounded by steam; this also prevents the too rapid formation of crust, and its subsequent cracking, consequent upon the increasing pressure of the heated gases of the interior, and so preserves a smooth exterior to the loaf.

210. The Austrian bakery in the Paris Exposition in 1867, for the production of loaf-bread, was provided with the steam-arrangement; but the oven of the Vienna bakery, on exhibition at the Vienna Exposition for the production of rolls, was a dry oven. One of the effects of heat in baking is that of destroying the yeast-plant, as already mentioned; this, however, is incomplete, as has been shown by Dr. Wiesner. To a certain extent, therefore, the yeast-plants continue to live for some time after the bread has been baked. It is partly to avoid the introduction of these living organisms that the universal practice prevails in Europe of eating the bread cold or stale. Another advantage is also gained by allowing the bread to become cold and dry. It is that the cell-walls coated with glassy starch—which renders them moist and adhesive when the bread is fresh and warm, and so disposes the bread to ball and become less pervious to the digestive fluids*—lose this adhesiveness on cooling by the absorption of the water from the glassy starch by the

* It is obvious that if the yeast-bread be eaten while warm, in the process of mastication it will become resolved by pressure into compact boluses, (the moist glassy starch being adhesive,) which having lost their cellular texture will resist the penetration of the gastric juices. Experiments made by Dr. Hammond, late Surgeon-General of the United States, who pressed the recently-baked yeast-bread into compact condition, showed that they resisted much longer the digestive powers of the stomach.

gluten in contact with it in the cell-walls; which water of hydration, as will be more clearly seeen, had been driven from the gluten to the starch by the elevated temperature of baking.

211. WHAT IS STALE BREAD?—Experiments made by the writer to determine the cause of the moistening of the interior of dry stale bread by the process of toasting furnished the material for the explanation.

Boussingault many years ago undertook the solution of this problem. He first showed that, in becoming stale, bread did not necessarily lose weight, as of water. He cooled recently-baked bread in hermetically-sealed spaces, and it became stale. He then sealed stale bread in a metallic tube and heated it. It became fresh, and again became stale on cooling. He repeated the process again and again, in all, forty times with the same sample, alternately heating and cooling, and with the last heating it became fresh, and with the last cooling it became stale. He concluded from his experiments that there was what he called a *molecular* change in the crumb when heating, and again when cooling, and he thought he had explained it. Thenard, who listened to Boussingault's paper before the Academy, suggested that bread was a hydrate, from which water was driven out by heat and re-absorbed by cooling; but it would seem that according to this view fresh bread should be the drier of the two. Neither explanation was satisfactory. When I found that gluten was a hydrate from which a moderate heat would expel water, and that, on cooling, this water was again taken into the constitution of the gluten, I applied this fact to the solution of the problem. The stale crumb may be regarded as a frame-work of gluten, coated with glassy, dried starch, which is not readily dissolved by saliva. Of course, when taken into the mouth, it requires time before it becomes flexible, so as to be easily compressed and force out the fluids it takes up by virtue of its capillary action. But by heating, the water of hydration of the gluten is driven out; the starch which invests the gluten is moistened and rendered flexible; and the whole crumb, recovering the sponge-like elasticity of fresh bread, yields its juices when masticated, and is palatable. To test this, I placed in one end of a glass tube a quantity of thoroughly air-dried gluten, and hermetically sealed it; I then placed the end containing the gluten in warm water, and beheld a few moments later moisture condensing on the interior of the upper portion of the tube, which was cool. On withdrawing the tube from the water after a few hours, the film of moisture had disappeared. Water had been driven out from the gluten by heat, and had been re-absorbed on cooling. I then placed another quantity of gluten in the bottom of a tube, above it a tuft of cotton, and above the cotton a quantity of loose shavings of very thin glacial starch. Now I expected that if moisture was given off from the gluten, it would penetrate to the space occupied by the shavings, half liquefy the glacial starch, and make it adhesive. In this condition, the starch-shavings would be gummed fast to the glass, and it would no longer be possible to shake them about.

212. The experiment realized my expectations. The solution then of the question of the difference between stale bread and bread freshened by heating or by toasting is this: *The gluten of the crumb-walls of stale bread which are stiff and brittle is dehydrated by the heat in freshening, and the water of hydration driven out softens the glacial, horny starch which coats and penetrates the gluten. Thus softened, the crumb is more palatable, because it is in condition to be dissolved by the saliva, and tasted. On cooling, the water is withdrawn from the starch, which is thereby rendered stiff, and restored to the gluten, and the bread becomes stale.*

213. EFFECTS OF HEAT IN BAKING.—The effect of the heat in baking, as shown in the difference between the composition of the crumb and crust of wheaten roll free from water:

	Crumb.	Crust.
Nitrogenous ingredients	11.296	10.967
Dextrine, gum, and soluble starch	14.975	16.092
Sugar	4.175	4.149
Oil	1.683	0.715
Starch	67.871	68.077

214. The crust has lost about one-half its oil, and a little of its nitrogen and sugar. It has gained in dextrine and soluble starch. The crumb has lost in starch, perhaps in the process of fermentation, which would be sooner checked in the crust.

The relative amounts of water in the crumb and crust and total loaf of bread, as determined by Professor v. Fehling, are:

	Per cent.
For the total loaf	44.30
For the crumb	48.92
For the crust	16.23

A peculiarity of bread made from the use of yeast or leaven, where the kneading has been prolonged, and which is conceived to be an evidence of its superior excellence, is the so-called "*pile*."

215. WHAT IS PILE?—This term, familiar to bakers, indicates, when prefaced by the epithet "good," and applied to bread, that a loaf so distinguished may be separated into strips, somewhat like the husks that coat an ear of Indian corn, or the coats that invest an onion. How this should appear in a loaf produced from a body apparently so homogeneous as dough is thought quite extraordinary. The explanation is, however, quite simple. Where the gluten of the flour is unimpaired by heat or souring, it retains its tenacity, even when greatly attenuated. When the dough is kneaded, it is spread out and folded over upon itself, again and again, from the border to the center; the surface is repeatedly dusted with flour, until these thin layers of flour, at last after long-continued kneading are everywhere present in the loaf, separating thin sheets and strips of fermented dough, each strip containing fibers of tenacious gluten. Now this fine flour constitutes a series of films of relatively diminished cohesion, so that when the loaf

is baked there are planes of easy separation alternating with sheets of tenacious crumb, having a direction from the bottom around the outside toward the center of the top, corresponding with the last foldings of the mass of dough, before placing it in the pan. These permit the loaf to be stripped off in coats, somewhat as pie-crust may be separated into flakes, and for a kindred reason. The pie-crust has been made by alternating layers of dough with layers of butter, and repeated foldings, to be followed with alternating extensions under the roller.

216. WHAT IS THE LOSS IN NUTRITIVE VALUE DUE TO THE PROCESS OF FERMENTATION?—This loss has been estimated by Dauglish as high as 10 per cent. It is due to the growth of the yeast-plant at the expense of the nitrogenous constituents of the flour, and to the conversion of starch into dextrine and sugar, and subsequently into alcohol and carbonic acid, both of which are lost; but which, in the conversion into gas and expansion by the heat of baking, give the raised loaf, which is about nine-tenths pores, or air-spaces, and one-tenth bread-substance. This estimated loss is conceived to be much too high. Heeren found the actual loss in weight to be 1.46 per cent., estimated on the anhydrous substance. Von Bibra found it but 2.1 per cent. Normandy's calculation, based on the production of carbonic acid to produce porosity, gives it at 2 per cent. The error in the high estimate is to be ascribed to the greater quantity of water which the unfermented porous bread is capable of holding.

217. THE QUESTION OF SIZE OF LOAF.—The Vienna bakers recognize in its fullest significance the proper relations between the crust and the crumb; so fixing the size of the mass of dough and so fixing the temperature of the oven that the bread when taken from the oven shall, every part of it, crust and crumb, be thoroughly cooked, none of it burned, and the whole, when warm, have an agreeable aroma, and, when cold, but fresh, shall be palatable in the highest degree without the addition of butter or edibles of any kind whatsoever.

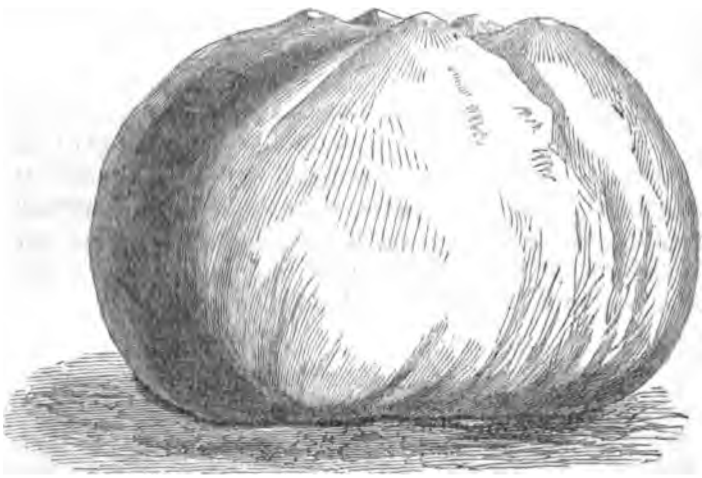
CHAPTER IV.

PROCESSES IN THE VIENNA BAKERY.

218. THE PREPARATION OF THE DOUGH FOR THE PRODUCTION OF VIENNA WHITE BREAD, THE IMPERIAL ROLL.—In nothing was the exposition of the Association of Vienna Bakers more striking than in its simplicity and cleanliness. Three classes of products were continuously turned out: first, the imperial roll, (the Vienna bread *par excellence;*) secondly, the loaf of rye and wheat bread and the loaf of pure rye-bread; thirdly, fancy bread, fruited cakes, sweet cakes, &c.

In the latter division, the variety produced was immense. With regard to both these and the forms of rye and rye and wheat loaves, it is not purposed to go into farther detail.

Fig. 70.



Kaiser-Semmel, or Imperial table-roll of Vienna.

219. IMPERIAL ROLL, (or *Kaiser-Semmel.*)—The bakery connected with the production of these rolls consisted of three departments: first, a store-room containing salt, fresh milk for daily consumption, and flour; secondly, the dough-room; and, thirdly the oven-room; in the store-room, the sacks of fine flour, including the best 45 per cent. of the high-milled best Hungarian wheat, or a smaller percentage if the wheat was not of the best quality, embracing the grades from the imperial extra to No. 5.

For the best imperial rolls made at the Vienna bakery, they employed

only the first four grades, Nos. 0, 1, 2, and 3, about 18 to 25 per cent. of the total wheat. These grades were also employed for the production of the tea-cakes, containing milk and butter, the *Gipfel*, or pinnacle cake, which has the form of a crescent, and contains milk and lard, and the *Brioche*, an oblong, slender roll, containing milk and sugar, neither of them containing water, mixed with the milk

220. The dough-room was an oblong apartment, well lighted on two sides. Along the center were racks for the support of long, smoothly-planed, movable boards, on which the dough-balls of the *Kaiser-Semmel* were placed for transportation to the oven. Along one whole side, and a part of two others, was a broad shelf, or continuous table, breast-high, for handling the dough. Opposite the long table was a sink, and a supply of hot and cold water. At one end was a zinc-lined trough, about two feet and a half wide and about eight feet long, semicylindrical in form, for setting the sponge and—

221. PREPARING THE DOUGH. Into the middle of this trough, flour was emptied from the sacks, leaving the ridge sloping down to the ends. Into a pail holding about five gallons, equal parts of milk and water were poured and left to stand until the mixture acquired the temperature of the room, which was between 70° and 80° Fahrenheit. It is then poured into one end of the trough, and intimately mixed, with the aid of the naked hands and arms, with a small amount of flour, making a thin emulsion. To this three and one-half ounces of press-yeast by weight, after finely crumbling in the hands, to every three quarts of the liquid, and one ounce of fine salt, were added, and intimately diffused throughout the mixture. The trough was then covered and left undisturbed for three-quarters of an hour. At the end of this time, the workmen, step by step, thoroughly incorporated from the neighboring pile an amount of flour sufficient to give the requisite texture to the dough. The determination of this point belongs to the department of unwritten art, but practically does not probably vary in first quality of flour, day by day, five ounces in fifty pounds from the proportion indicated in the following table given me by Roman Uhl:

8 pounds of flour;
3 quarts of mixed milk and water in equal proportions;
3½ ounces of press-yeast;
1 ounce of salt.

The mass of dough so prepared is covered and left for two hours and a half, at the end of which time it presents a smooth, tenacious, puffed, homogeneous mass of slightly yellowish color, which, when subjected to the pressure of the hand, yields to indentation without rupture, and on withdrawing the hand recovers, in a short time, but not instantly, its original outline and smooth surface. It is now in condition to be weighed into pound masses, and cut with a convenient machine into twelve smaller masses of uniform equal weight, and having a thickness of about three-quarters of an inch. Workmen take individually these smaller

flat masses, lay the back of the forefinger of one hand upon each one in turn, and with the thumb and forefinger of the other hand draw out slightly each corner of the irregular mass, and fold it over to the center, to be secured by pressure and adhesion, when the whole is reversed, and placed upon the smooth board, already mentioned, to complete the fermentation preparatory to being transferred to the oven. Before being introduced into the oven, the little rolls are again reversed, and restored to their original position, having considerably increased in volume, to be still farther enlarged in the oven to at least twice the volume of the original dough. They were distributed over the bottom of the oven near to, but not touching, each other, where they remained for about fifteen minutes, when they were taken out, with the same long-handled, thin, flat, wooden shovel, or spatula, on which they were introduced. As all parts of the oven are not alike heated, some of the rolls are likely to bake more rapidly than others, and the workman who opens the door to examine them from time to time changes their places, replacing the more exposed with others from a less heated portion of the oven, so that but a small proportion are rejected as culls from having been overbaked. If it is desired to glaze the surface, they are touched in the process of baking with a sponge dipped in milk, which, besides imparting to them a smooth surface, increases the brilliancy of the slightly reddish cinnamon-color, and adds to the grateful aroma of the crust.

222. THE OVEN.—In regard to the construction of the Vienna oven, there seems to be nothing of complexity to challenge attention. It was made of brick, presenting the edges and not the flat surfaces, having a very low arch. The floor was oblong-oval in form, having an inclination toward the door of about eight degrees. The ovens in the city were built substantially on the same simple plan.

The oven was fired eight times in the twenty-four hours with dry ight wood. The baking for the day commenced at two o'clock in the morning and closed late in the afternoon. The person in charge of the oven of the Exposition was introducing and withdrawing the rolls and changing their place from cooler to warmer places or the reverse at short intervals during the whole time between two firings. As the rolls were brought out, any that were overbrowned were culled out, to be sold elsewhere than at the Exposition restaurant, and at a cheaper rate.

223. Fig. 71 is a vertical section through the greatest depth, and Fig. 72 a section through the greatest horizontal diameter, of the average *Kaiser-Semmel*, of which 12 weigh 500 grams, one-half a kilogram. One *Kaiser-Semmel* weighs 643 Troy grains.

224. ADVANTAGES OF THE VIENNA BREAD—SECRET OF ITS EXCELLENCE.—From what has been said, it will be apparent that the virtues of this bread had their origin primarily in the Hungarian wheat. These are not due to any particular variety of wheat, or to any marked peculiarity of soil or mode of fertilizing, or to a mean annual temperature

characterizing the climate of Hungary as a whole, but, as already intimated, to a *peculiarity of the climate*, uniting special dryness of the air during the hot season, from the time of the development of the milk of the berry through the period of its segregation of the various constituents of the grain, down to its being housed for thrashing.

Fig. 71.

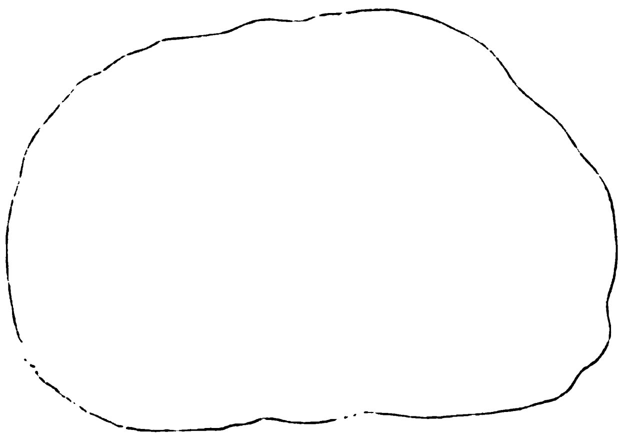
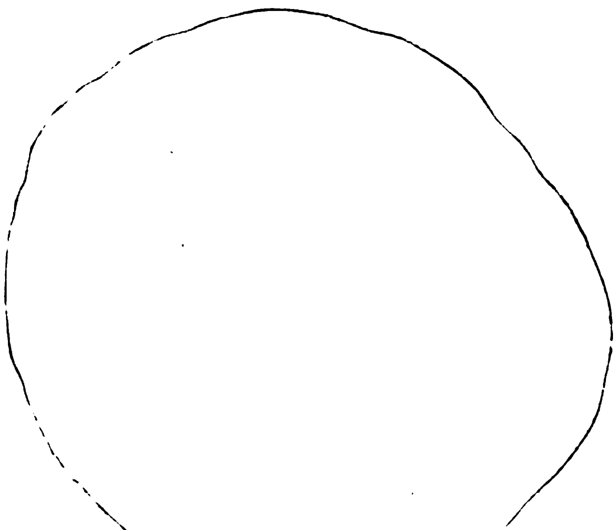


Fig. 72.



With a view to finding out what influence the climate of Hungary exerts on wheat, I have been furnished by Graf Zichy with several samples of great interest. They are original Australian white wheat,

and the produce of a portion of the same sample, on Hungarian soil, after some years. The changes, if one might form a conclusion from so limited a range of observation, seem to be, in the first place, (*a*) from white more or less to redness, that is, a change in the amount of red or orange pigment in the color or seed coat; and (*b*) a change to a more flinty quality of the grain; and (*c*) a more shrunken berry; in the second place, to the process of grits or high milling, by which the *organized forms* of the grain are *disintegrated* or detached from each other *without crushing*, and *opening* the gluten-cells, which renders the flour produced by the low-milling process liable to become musty and sour; in the third place, to the employment of a selected portion of the flour so produced, varying, according to the quality of the wheat ground, from 25 to 45 per cent. of the whole grain; and, in the fourth place, to the introduction of press-yeast, which renders the process of making dough *quantitative*, and less a work of art; avoids the lactic, acetic, and other offensive fermentations; and yields a bread, the dough of which has been subjected to the process of purely vinous fermentation, producing only alcohol and carbonic acid, and imparting no taste due to the action of yeast; and, lastly, to the production of the bread in rolls or loaves, so small as to provide for the thorough cooking of the interior, at the same time that a thin, aromatic, palatable crust of substantially unimpaired nutritive qualities has been uniformly produced over all the surface, without any portion of it having been rendered inedible from heat too high or too prolonged. The temperature of the oven at the Vienna Exposition was not far from 500° Fahrenheit.

225. As the coagulation of the albumen, which is the principal change that takes place in the cooking of the loaf, is affected at a temperature below 212° Fahrenheit, and as flour is not browned except at a temperature much above this point, it is easy to see how skillfully the Vienna baker has adapted the size of the roll to the object to be gained. Where the loaves are large, the surface must be protected by baking at a prolonged lower temperature, or by surrounding the loaves with steam until nearly the close of the process of baking, which prevents the formation of the inedible crust. With the latter arrangement, wheat and rye loaves of a pound weight were shown the jury at the steam-bakeries at Wittingau, one of the seats of Prince Schwarzenberg, which loaves were encased in a thin crust of exceeding delicacy and palatableness, and presented a crumb of uniform lightness and most acceptable taste.

226. ADVANTAGE TO THE CONSUMER OF ROLLS RATHER THAN LOAVES.—The mode of producing bread in Vienna, where all the baking is in public bakeries, enables the householder to place upon his table day by day absolutely fresh bread in precisely the quantity required for consumption. He thereby escapes the waste attendant upon the accumulation of stale bread, and he also avoids the deterioration and

losses attendant upon keeping a stock of flour in his house. He may thus have a better bread with the expenditure of a given sum of money than he could have if he maintained all the appointments of a bakery within his own dwelling.

227. CAN WE HAVE VIENNA BREAD IN AMERICA?—The answer in general is, we may. To assure it, we must have, first, as good flour as the bakers of Vienna have; second, we must use the press-yeast; and, third, we must pursue the same processes of preparing the dough and baking.

Good flour can only be made from sound, pure wheat, and, having the wheat to start with, by good milling; and this means, in general, flinty wheat reduced by the process of high or half-high milling, and a selection of the products of the milling, not to exceed one-half of the total weight of the wheat ground. Good, fresh middlings flour would compare favorably with the average Hungarian flour.

Press-yeast is now produced in this country. It should be of recent preparation; sweet, so that it will yield only alcohol and carbonic acid as products of fermentation.

228. The sponge should be made with a mixture of half milk and half water. The proportions of the ingredients, temperature, and the processes of preparation of the dough in bulk and detail as given in the account of Vienna bread in the 221st paragraph, will give the unbaked loaf.

In general these proportions are:

8 pounds of flour;
3 quarts of mixed water and milk in equal proportions;
3½ ounces of press-yeast;
1 ounce of salt.

229. The baking requires an oven of no especial complexity, but should be capable of maintaining a constant temperature of about 500° Fahrenheit.

The loaves should be of size to require not more than from 15 to 20 minutes to bake completely; that is, to thoroughly cook the interior by the time the outside has assumed a delicate thin reddish or cinnamon-brown crust, and become palatable in every part. If eaten at its best, that is, soon after it has cooled, or at least during the day of its preparation, it will not fall behind the average first quality of Vienna *Kaiser-Semmel.*

APPENDIX A.

230. DEMPWOLFF'S INVESTIGATION OF THE HUNGARIAN WHEAT AND WHEAT-FLOUR FURNISHED FROM THE PESTH WALZMÜHLE, (CYLINDER-MILL.)—The flour in this year (1869) was 78 per cent. of the wheat; the bran, 22 per cent. These were included in fourteen distinct products.

The flour was produced from a mixture of two-thirds Theis and one-third Banat wheat, of which the analysis of the whole grain gave—

Water	10.51
Ash	1.50
Nitrogen	2.24
Starch	65.41

The ash of the whole grain yielded in 100 parts—

Fe_2O_3	0.404
CaO	4.275
MgO	14.862
KO	31.825
NaO	1.016
PO_5	49.912
SO_3	0.101
CO_2	0.086
	102.481

The ash contained—

Water	10.5	Lime	4.275
Ash	1.5	Magnesia	14.862
Gluten	14.4	Potash	31.825
Starch	65.4	Soda	1.016
Oil and woody fiber	8.2	Phosphoric acid	49.902

231. The products of the milling gave in 100 parts—

A and B,	0.489	grits.
No. 0,	3.144	imperial extra flour.
No. 1,	2.635	
No. 2,	5.291	
No. 3,	7.165	
No. 4,	14.757	roll-flour.
No. 5,	17.935	
No. 6,	15.419	bread-flour.
No. 7,	6.805	
No. 8,	2.576	black flour.
No. 9,	9.516	bran.
No. 10,	9.000	
No. 11,	1.290	clippings.
	3.988	loss.

232. From this wheat, 100 parts yielded—

Groats and extra imperial flour	18.724
Semmel or roll flour, Nos. 4 and 5	32.682
Bread-flour, Nos. 6 and 7	22.224
Black flour, No. 8	2.576
Bran	18.516
Offal, clippings, &c	1.290
Lost	3.988
	100.000

In every 100 parts are contained—

	Water.	Ash.	Gluten.	Starch.
Groats and extra flour	10.6	0.41	11.7	70.0
Semmel or roll flour	10.5	0.60	13.3	67.2
Bread-flour	10.7	0.96	15.4	63.5
Black flour	9.5	1.55	14.9	61.0
Bran	10.7	5.46	14.3	43.6
Offal	9.2	2.65	15.2	0.0

Each 100 parts of flour contained—

Number.	Water.	Ash.	Nitrogen at 212°.	Nitrogen in common flour.	Starch.
A	11.050	0.398	2.089	1.858	69.983
B	11.545	0.386	1.874	1.658	69.530
0	11.077	0.380	2.010	1.808	72.145
1	10.618	0.416	2.071	1.851	71.017
2	10.492	0.452	2.087	1.868	68.867
3	10.142	0.481	2.122	1.907	68.386
4	10.421	0.586	2.212	1.981	67.302
5	10.544	0.611	2.435	2.178	67.176
6	10.748	0.764	2.611	2.329	65.631
7	10.674	1.176	2.788	2.491	61.773
8	9.527	1.549	2.570	2.325	61.031
9	10.690	5.240	2.518	2.249	45.838
10	11.150	5.680	2.513	2.233	41.453
11	9.235	2.648	2.616	2.375	0.000

In 100 parts of ash there are contained—

Number.	Fe_2O_3	CaO	MgO	KO	NaO	PO_5	Total.
A	0.525	7.296	6.899	34.663	0.988	49.721	100.092
B	0.583	7.718	6.857	34.669	0.891	49.218	99.936
0	0.630	8.057	7.008	35.482	0.744	48.976	100.125
1	0.643	7.946	7.105	35.285	0.675	48.976	100.428
2	0.627	7.454	7.795	34.254	0.678	49.519	100.327
3	0.635	7.094	8.343	33.876	0.690	49.306	100.344
4	0.596	6.798	9.924	32.715	0.650	50.056	100.739
5	0.570	6.791	10.574	32.239	0.726	50.187	100.087
6	0.334	6.626	10.870	30.386	0.946	50.146	99.308
7	0.425	5.536	12.234	30.314	1.260	50.204	99.973
8	0.484	4.741	12.947	30.299	0.974	50.173	99.618
9	0.208	2.747	16.861	30.672	0.701	50.152	101.341
10	0.436	2.502	17.349	30.142	1.080	49.112	101.621
11	1.671	8.203	13.023	31.489	2.144	44.054	100.584

The nitrogen gave of albuminoids—

(*a*, in normal flour; *b*, in normal flour, dried at 212° Fahrenheit,)

Number.	*a*	*b*		*a*	*b*
A	11. 910	13. 396	5	13. 961	15. 609
B	10. 628	12. 012	6	14. 872	16. 737
0	11. 520	12. 891	7	15. 968	17. 871
1	11. 865	13. 275	8	14. 904	16. 474
2	11. 974	13. 378	9	14. 417	16. 141
3	12. 224	13. 602	10	14. 314	16. 109
4	12. 699	14. 179	11	15. 224	16. 769

With the above numbers referred to 100 parts of whole wheat, the several percentages of milling products show the following composition:

Number.	Production.	Ash.	Nitrogen, *a*, 212°.	Nitrogen, *b*, normal flour.	*a*, albuminoids.	*b*, albuminoids.	Starch.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
A and B	0. 489	0. 0019	0. 0096	0. 0085	0. 0629	0. 0557	0. 341
0	3. 144	0. 0121	0. 0663	0. 0596	0. 4254	0. 3824	2. 268
1	2. 635	0. 0109	0. 0545	0. 0487	0. 3498	0. 3128	2. 238
2	5. 291	0. 0239	0. 1051	0. 0940	0. 6739	0. 6028	3. 543
3	7. 165	0. 0344	0. 1520	0. 1365	0. 9744	0. 8705	4. 899
4	14. 757	0. 0864	0. 3264	0. 2923	2. 0924	1. 8744	9. 931
5	17. 925	0. 1095	0. 4364	0. 3903	2. 7979	2. 5024	12. 031
6	15. 4195	0. 1178	0. 4025	0. 3592	2. 5807	2. 3030	10. 119
7	6. 805	0. 0800	0. 1897	0. 1694	1. 2141	1. 0867	4. 203
8	2. 576	0. 0349	0. 0662	0. 0598	0. 4245	0. 3835	1. 573
9	9. 516	0. 4886	0. 2296	0. 2139	1. 5359	1. 3712	4. 261
10	9. 000	0. 5112	0, 2261	0. 2008	1. 4427	1. 2821	3. 730
11	1. 290	0. 0341	0. 0317	0. 0287	0. 2035	0. 1842	....
Total	....	1. 4611	2. 3066	2. 0617	14. 7781	13. 2097	58. 948
Found	....	1. 505	2. 503	2. 2399	16. 044	14. 351	65. 407
Difference	....	−0. 044	−0. 197	−0. 178	−1. 266	−1. 142	−6. 459

The proportions of the principal nutritive salts, as lime, magnesia, potassa and phosphoric acid, present themselves in the different products as follows:

Number.	Ca O	Mg O	K O	P O_5
A and B	0. 00014	0. 00013	0. 00065	0. 00090
0	0. 00104	0. 00085	0. 00429	0. 00595
1	0. 00086	0. 00077	0. 00334	0. 00531
2	0. 00178	0. 00186	0. 00828	0. 01183
3	0. 00244	0. 00287	0. 01165	0. 01696
4	0. 00587	0. 00857	0. 02826	0. 04325
5	0. 00744	0. 01158	0. 03530	0. 05495
6	0. 00780	0. 01280	0. 03573	0. 05972
7	0. 00442	0. 00978	0. 02425	0. 04016
8	0. 00165	0. 00452	0. 01057	0. 01851
9	0. 01342	0. 08238	0. 15006	0. 24505
10	0. 01279	0. 08865	0. 15408	0. 24106
11	0. 00279	0. 00444	0. 01074	0. 01502
Total	0. 06584	0. 22367	0. 47897	0. 75103
Found	0. 06245	0. 22920	0. 47770	0. 75887
Difference	+0. 00339	−0. 00553	+0. 00127	−0. 00784

According to this result there was lost—

Ash	0.043
Albuminoids	1.142
Starch	6.459
	7.644

(3.988 of the product was dissipated; therefore, less than about 3.8 per cent. was found.)

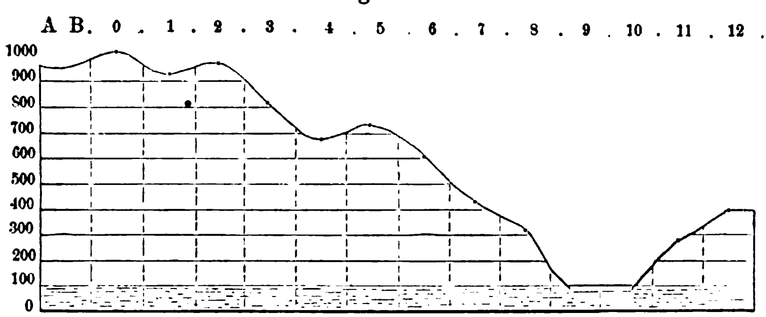
The difference is to be sought in the starch, as the point where all the starch and dextrine are changed into sugar cannot be accurately determined.

The relations of phosphoric acid to nitrogen are as follows:

A and B	100 : 944
0	100 : 1010
1	100 : 911
2	100 : 976
3	100 : 807
4	100 : 676
5	100 : 710
6	100 : 601
7	100 : 422
8	100 : 323
9	100 : 87
10	100 : 83
11	100 : 191
12, (whole wheat)	100 : 295

These relations are graphically shown in the annexed diagram, Fig. 73.

Fig. 73.



An analysis was made of a flour that contained all the bran, and it was found to be very nearly that of the whole kernel:

Water	10.743
Nitrogen	2.506
Starch	64.475
Ash, (containing Fe_2O_3, 0.852; CaO, 4.246; MgO, 14.721; KO, 31.898; NaO, 0.704; PO_5, 49.720 = 102.141)	1.503

Another flour, containing all the product except 13 per cent. of bran, was analyzed, and gave the following result:

Water	10. 548
Nitrogen	2. 518
Starch	65. 660
Ash, (containing Fe_2O_3, 1.338; CaO, 5.085; MgO, 12.425; KO, 31.456; NaO, 1.878; PO_5, 48.761 = 100.943)	1. 032

These analyses show that the coarser the flour the more ash it contains, and the increase is proportioned to the increase of the lime and potassa and the diminution of the magnesia. The percentage of nitrogen increases to the bread-flour, Nos. 6 and 7, and diminishes with the bran, although the difference is only 0.8 per cent. (Dingler's Polytechnisches Journal, 1869, pp. 332–338; Annalen der Chemie und Pharmacie, 1869, Band cxlix, p. 343.)

APPENDIX B.

PHOSPHATIC BREAD.

233. IMPERFECTION OF THE VIENNA BREAD.—All improvements in making bread point to its being eaten fresh, but not warm. This necessity makes urgent the adoption of a process by which the labor of making the bread for household consumption shall be reduced to a minimum. Either the bread must be produced by a public baker, where the waiting-time can be utilized, or the yeast-process must, in private families, give place to a method which does not require the time and the care of this process, such as the process of self-raising flour.

With all its excellencies and attractiveness, the Vienna bread is not as nutritious as the rye-bread or as the brown wheat-bread.

The two most important nutritive constituents of the wheat are the albuminoid bodies, largely lodged in the gluten-coat of the grain, and the phosphates, which are associated with them. Both these constituents are largely lost from the flour both by the high and low milling processes. The percentage of nitrogen, which is the same in all the nitrogenous constituents of the wheat, is on an average not far from two, and deducting the weight of the woody fiber of the outer and inner coats of the bran, including the gluten-comb, but not the contents of the cells or the starch-granules embedded in it, which contain but little nitrogen, the nutritious portion of the berry contains *less* than two per cent. of nitrogen.

234. The flour of the great Pesth *Walzmühle* (cylinder-mill) at the Vienna Exposition yielded to my analyses the following percentages of nitrogen:

	Nitrogen.
Grits, A	2.25
No. 0	1.68
No. 1	1.68
No. 2	1.72
No. 3	1.72
No. 4	1.74
No. 5	1.80
No. 6	1.84
No. 7	1.80
No. 8	1.90
Bran, No. 9	1.98
Bran, No. 10	2.21

My analyses yielded also the following percentages of phosphoric acid:

	Phosphoric acid.
Grits, A	0.24
No. 0	0.14
No. 1	0.21
No. 2	0.22
No. 3	0.17
No. 4	0.25
No. 5	0.35
No. 6	0.24
No. 7	0.21
No. 8	0.36
Bran, No. 9	2.96
Bran, No. 10	1.74

The percentage of phosphoric acid in the whole grain is about one, (1.00.)

235. A glance at these results will show why the peasantry of Austria and Hungary, and, indeed, of Europe in general, prefer the black bread made from the whole meal, because of its greater nutritive value—because the laborer can be sustained on the black bread and cannot on the white. The consideration of these conditions led the late Baron Liebig to remark as follows:

"The significance of the nutritive salts in food is sufficiently well known to physiologists; it is known that without their co-operation the other constituents of the food are incapable of affording nourishment.

"By simple washing of fresh or boiled meat with water, which abstracts the nutritive salts, it would become incapable of serving in the preservation of life; the nutritive salts of wheat are identical with the nutritive salts of meat, and one understands that what is true for meat must also be true for bread, and that the nutritive value of flour is less in the same proportion as it contains less of the nutritive salts than the grain.

"The nutritive salts of meat and wheat are phosphates, and consist of compounds of phosphoric acid with potassa, lime, magnesia, and iron; the simple relations of the quantity of these substances, contained in wheat and flour, as shown by chemical analysis, will be sufficient to make obvious, the differences in the nutritive value of the two," &c.

236. The researches of Magendie, made many years since, established beyond question the superiority, for purposes of nutrition, of the bread made from whole meal as compared with bread made from the fine flour. He found that while dogs fed upon white wheat-bread alone after a time became ill, lost strength, and ultimately perished, dogs fed upon bread made from whole meal lived in health indefinitely long.

Chossat found that absolutely clean wheat—wheat that has been

washed to remove any traces of calcareous earth adhering to its surface, would not sustain pigeons in health when supplied in addition with absolutely pure water only. After a time, their bones became thin and frail, and were unable to bear the weight of the birds; the phosphate of lime of the bones having been transferred to sustain the activity of organs more essential to life. They ultimately perished. Pigeons fed upon the same wheat and the same pure (distilled) water, and having access to lime compounds, continued in perfect health. Even pigeons nearly perished from having been fed only upon the diet first mentioned, upon being supplied with carbonate of lime were wholly restored to health.

237. It is well known that the peasantry, not of Austria only, but of all Europe, and a large proportion of the middle classes, habitually eat because of its nutritive value, brown bread; that is, a bread containing the bran with its phosphates. The higher classes in England prefer, two or three times a week, as an article of luxury, wheaten bread made from whole meal.

238. The nutritive value of oat-meal, and of the porridge made from oat-meal groats, an established dish upon the breakfast-table of Scotland, is well known.

The bread made from whole rye-meal, the *Pumpernickel* of Westphalia, containing all the phosphates due to the normal grain, is widely used by the best classes in Germany.

The rice, which is the great staple of food for so large a fraction of the oriental world, contains 20 per cent. more phosphoric acid in its ash and twice as much lime as the average wheat.

The Indian corn, the meal of which, wrought into the various forms of farinaceous food, has long been the basis of so large a proportion of the nutrition of the labor of the South in this country, differs but little in its percentage of phosphates from whole wheat.

239. These phosphates are indispensable to the nutrition of all higher organisms. They enter into, and constitute a part of, not only the bones, but every muscle, every nerve tissue; and in each secretory organ there seems to be a special accumulation, to be employed in the elaboration of the products which are secreted.

The observation that cattle prefer grass grown in meadows enriched with ground bone is in keeping with the practice, now well known, of feeding cattle upon bone-meal.

240. The significance of these considerations led to an investigation in Germany by M. Meyer of the effect of restoring in mineral condition the phosphates of rye-bran to the flour from which the bran had been separated. These experiments, made in 1870–'71, though less extended than might have been desired, and though defective somewhat in theory, so far as they went showed that, with the restoration of the phosphatic constituents of the bran, the bread was more nutritious than when made with the whole rye-meal including flour and bran.

241. The mode by which this restoration was effected consisted in the employment of an acid phosphate of lime and magnesia in the form of a dry powder; this was mixed with an alkaline carbonate sufficient to neutralize the acidity of the phosphoric acid, and these mixed powders intimately incorporated with the dry flour in such quantity as to restore to it the phosphoric acid, lime, magnesia, and alkali lost with the bran. On adding to this mixture of flour, acid phosphate, and alkaline carbonate, sufficient water or milk to produce with stirring a dough, the phosphoric acid and alkaline carbonate were dissolved, and reacting upon each other evolved carbonic acid in the form of gas. This gas appearing in every part of the dough gave it the required porosity or cellular structure, which was preserved by immediate baking.

242. The changes produced in the flour by this process are less than in the process of raising by yeast, partly because of the brief exposure of the gluten and starch to the solvent power of the water employed in making the dough, but chiefly because no deterioration of the nitrogenous constituents of the gluten or of the starch to supply material for the process of fermentation has taken place. The amount of the deterioration in nutritive value which bread made by the yeast or leaven process experiences, though doubtless frequently overestimated, is, nevertheless, considerable, even when pure press-yeast is employed, and much more when inferior yeast or old leaven is employed.

In the latter case, the deterioration is not confined to the degradation of the nitrogenous constituents and of the starch, yielding lactic, acetic, and other acids and offensive exhalations, but is seen in the imperfectly-raised, heavy, sodden, indigestible bread produced.

243. None of all this class of effects are produced in the process of raising with acid phosphate and a carbonated alkali. An excellence in the whitening of the crumb over that imparted to any bread produced by pure yeast, is to be ascribed to the action of the acid phosphate.

Another advantage in the phosphatic bread is that it contains no yeast-plants, and of course none to survive exposure to the heat of the baking temperature. As a consequence of the brief exposure to the action of water, the starch is less perfectly converted into the glassy texture, and is less liable to lose its cellular structure by pressure, and the walls, being coated with a larger proportion of granular starch, are less coherent. The crumb less easily loses its elasticity, less readily forms into compact boluses, and more readily imbibes the digestive fluids. As a consequence, persons of sensitive organs of digestion, who cannot eat hot yeast-bread, eat the hot phosphatic bread, enjoying the grateful aroma and flavor of fresh bread without conscious inconvenience. But the chief advantage is that to which Baron Liebig has called especial attention, the increase in the nutritive value, amounting to from 12 to 15 per cent., arising from the restoration of the phosphates lost with the bran. This bread having no yeast-plants does not mold, while great complaint was made of the

army bread in use by the Austrian and German armies on account of its tendency to mold.

244. This mode of making bread, which was introduced by Baron Liebig into Germany, was tried in several kingdoms of Europe, and met with great acceptance in all particulars except one, and that was in the inferiority in size of the loaf produced from a given weight of flour with the phosphatic preparation as compared with the loaf produced by yeast.

As the phosphatic process has been successfully employed for a long period in the United States, and as the publications in relation to it have found their way into all the text-books, repertoriums, and recent chemical and industrial works, like "Enyrim on Baking," for example, and especially as Baron Liebig had taken much pains to introduce the method into Germany, it was natural that the inventor, although a juror, should be requested to exhibit the practical details of the process at the Exposition.

The Archduke Albrecht had remarked, in looking through the collections of improved arms and devices for the relief of the sick and wounded, that he saw nothing contemplating improvements in the food of the soldier in the field.

245. As the phosphatic method enables the soldier to provide himself with fresh bread equally nutritious, because containing all the phosphates of the original grain, and more nutritious, because more palatable, since it contains none of the objectionable peculiarities that attach themselves to the bread made with yeast or leaven from the whole meal; an offer was made by the inventor, "*hors concour*," as being a juror and commissioner, he could not be an exhibitor, to show the process in all its details to the war department of Austria. The offer was accepted, and the minister of war detailed a commission to witness the practical exhibition of the process at the Vienna bakery within the grounds of the Exposition. Through the kindness of Professor Schrötter, secretary of the Imperial Academy of Sciences, the conveniences of his laboratory at the imperial mint were placed at the disposal of the inventor for the preparation of the acid phosphate. With this acid powder and bicarbonate of soda, dough from the extra imperial flour, from rye-flour, and from a mixture of wheat and rye flour, was prepared in a few moments, and baked both in the oven and on the hearth outside, to show, in the interest of the military service, that the conveniences of the oven were not necessary in order to its ready baking.

In the latter experiment, the dough was placed between two thin sheet-iron troughs, (small stove-pipe cut in half lengthwise, and the straight edges flanged outward,) their curved surfaces turned toward each other encasing the dough, and the whole placed in hot ashes and coals. The exhibition was in all respects satisfactory. The loaves were

porous in every part, and the taste in no respect inferior to the best Vienna bread made from corresponding flours. There were present at the exhibition of the process, besides the commission from the war department, Roman Uhl, who courteously placed the conveniences of the bakery at the disposal of the inventor, members of the international jury of the fourth group from various countries, and other gentlemen interested in the subject of improvements in the process of making bread.

246. It was obvious, as the result of this experiment, that by this process bread might be prepared at short notice from the Hungarian flour, which should unite all the excellencies of the Vienna bread made with press-yeast, and have restored to it all the nutritive value due to the phosphates of the original whole wheat.

247. REFERENCES.—In the preparation of the foregoing report, I have been indebted to various persons, whose names are given below, and who have aided me personally in the collection of material, or whose published researches and works I have consulted and quoted.

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C.

COMMERCIAL FERTILIZERS.

PETER COLLIER.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

COMMERCIAL FERTILIZERS.

BY

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CHAPTER I.

INTRODUCTION.

CONSTITUENTS OF PLANT-FOOD AND WHENCE OBTAINED; EXHAUSTION OF SOILS; THE BLACK SOIL OF RUSSIA; EXHAUSTION NEVER COMPLETE; POTASSIUM AND PHOSPHORUS; NITROGEN.

1. CONSTITUENTS OF PLANT-FOOD AND WHENCE OBTAINED.—During the last half century there have been made in England, Germany, France, and our own country, careful chemical analyses, amounting, in the aggregate, to some thousands of the various grasses, grains, roots, and fruits, the development and culture of which is the chief concern of the agriculturist. These analyses all show that the sources of supply whence the vegetable world derives its food are the atmosphere and the earth, and that though receiving but comparatively a small percentage from the earth, (from one to five per cent., as a general thing,) this amount is invariable, within narrow limits, and indispensable. These analyses show, also, that of the sixty-five elements composing the atmosphere and earth, plants select for their food but a small number, chief among which are carbon, oxygen, hydrogen, nitrogen, calcium, magnesium, potassium, sodium, iron, sulphur, phosphorus, silicon, and chlorine. Occasionally certain other elements are found, but their presence in the plant appears to be rather accidental than necessary. Of the list above given, the first four mentioned are obtained directly or indirectly from the atmosphere, the remainder are furnished by the soil. Moreover, these analyses still further show, that while different plants vary widely in the relative amounts of the various elements which they require as food, this difference is in amount rather than in kind, since, almost without exception, every plant known requires for its growth each of the several elements given in the above list; but it is also noteworthy that certain families of plants, allied to each other more or less closely, resemble each other in the food necessary to their growth; *e. g.*, the cereals, as a class, require large amounts of phosphorus and potassium; the clovers, large amounts of potassium and calcium; the root-crops, large amounts of potassium.

Numerous experiments have been made with soils artificially prepared, in which there existed no food available to the plant other than it might derive from pure water and the atmosphere, and in every case it has been found that, as soon as the growing plant had exhausted the scanty supply of nutriment stored up in the seed, it has withered and

died. Similar experiments have been tried where the plants have been supplied with such food as analyses have shown them to need, and such plants have grown and perfected their seed.

Obviously, from the above experiments, the conclusion is inevitable, that plants resemble animals in this, that they demand certain supplies of food for their development; and it is also true that since the various kinds of food adapted to plant-life are simpler in their composition, being derived from the mineral compounds present in the earth and atmosphere, the plant has not that wide and almost unlimited choice of food, which is presented to the animal, whose food, unlike that of the plant, belongs to organic and more complex compounds, many of which, though widely different in physical character, are very closely related in chemical composition, and capable, the one or the other alike, of giving to the animal organization those proximate constituents necessary to its growth and perfection.

If now we examine the earth, whence the supplies of plant-food are primarily derived, we shall find that those elements taken from it by the plant differ very widely in their comparative abundance, and that while two or three of them make up the greater part of most soils, some others are present in but small quantity, while others still constitute but a very small fraction of a per cent. of the total amount. And yet so small is the absolute amount actually needed by the plant, and with such marvelous success are the roots adapted to search out and assimilate these scanty supplies, that the plant ordinarily thrives well when placed upon virgin soil.

2. Exhaustion of soils.—But, if successive crops are removed from the soil, without any return of these mineral matters which are necessarily carried off in them, there generally, if not invariably, comes a time when a marked decrease in the annual harvest is seen, which decrease continues until it reaches a point at which it steadily remains, with no further perceptible change in either direction. If now we consider the process of formation through which our soils have passed, we shall see that those supplies of mineral food have been derived from the gradual disintegration and decay of the rocks, which are themselves composed of these very mineral constituents, and that this decay and disintegration is constantly going on in the soil, thus adding successive supplies of food to growing plants. Adding it in this, that though present in the soil before, it was, as it were, locked up in chemical compounds and mechanical conditions which rendered it unavailable to the plant. Decay, then, and disintegration result in breaking up these chemical compounds into simple ones, and overcoming these mechanical conditions by pulverization, so, as it were, to unlock these supplies and furnish them to the growing plant.

3. The Tchernozème or black soil of Southern Russia.—The importance of this last consideration—the physical condition of soils—is clearly set forth by Professor Ilyenkow, of the Academy of

Agriculture and Forestry, at Pétrovsky, near Moscow, in an exhaustive treatise upon *tchernozème*, or the black soil of the prairies and steppes of Southern Russia. This soil covers an area of not less than 95,000,000 hectáres, about 235,000,000 acres, and constitutes the garden of Russia, yielding not less than seven-tenths of all the grain produced in European Russia, and giving support and employment to more than 22,000,000 inhabitants, wholly engaged in agricultural industry. In conclusion he remarks: "This rapid examination of the chemical composition of the *tchernozème*, permits me, it appears, to draw this general conclusion, that the superiority of this soil of ours consists not in this, that the *tchernozème* contains a greater quantity of those constituents necessary to the development of plants than other soils, but in this, that these constituents are found present in a state of greater subdivision, that they are more equally distributed through the soil, and that they possess a more complete chemical preparation for their assimilation by the roots of plants. Also, that the conditions of moisture, heat, and light being satisfactory, the rootlets of plants as they are developed find everywhere in the *tchernozème* nutritious food in a condition favorable for absorption. Also, that the quantity of nutritive elements contained in other soils do not produce the same results, because that these elements, though present, are not sufficiently elaborated, are not in that condition that they present themselves readily to the absorbing action of the roots, are not in that condition of disintegration and equal distribution throughout the soil that the rootlets of plants are able to reach them. The Russian proverb, '*One cannot distinguish the generous from the rich,*' may be most appropriately applied to our *tchernozème.* It appears rich because it is generous."

If now the natural changes going on in the soil are sufficient to liberate annually from these insoluble compounds as much of those mineral constituents as the crop removes, it is clear that, practically, exhaustion could never result. In practice it is, however, found, almost invariably, that exhaustion is soon effected of one or another of the necessary constituents, and which one is soonest exhausted depends, first, upon the amount present in the soil and annually liberated, and, second, upon the kind of crop grown; since, as we have seen, the demand made upon the soil for food differs with the crop, certain crops requiring large amounts relatively of one constituent, and other crops large amounts relatively of some other.

Another important result of agricultural investigation to be observed is, that since the plant derives all its food through the roots, it is capable only of taking up into its circulation and assimilating such food as exists in solution. Mineral food, then, to be available to the plant must exist either in solution or in a soluble condition.

4. Exhaustion never complete.—It follows, then, that exhaustion is rarely, if ever, general, but is due to the removal of one or another of those constituents necessary to the growth of the plant; and absurd

as would be the practice of a physician who with a single remedy would hope to alleviate all manner of disease, so is it to hope that exhaustion of the soil is to be cured by the application of any special fertilizer.

5. POTASSIUM AND PHOSPHORUS.—The analyses of various agricultural products already referred to have shown, that among the mineral constituents taken up as food by the plant there are only two which are likely to be exhausted; since these two are present, generally, not only in small quantity in the soil, but are taken up relatively in large quantity by the plants. These two are potassium and phosphorus, and obviously the only way to replace these elements when deficient is by adding to the soil compounds containing these elements.

6. NITROGEN.—Of those constituents necessary to the plant which are derived from the atmosphere, it is generally believed that there is furnished to the plant an abundant supply at all times, with the exception alone of nitrogen.

CHAPTER II.

COMMERCIAL FERTILIZERS.

IMPORTANCE OF PHOSPHORIC ACID; ANNUAL CONSUMPTION IN ENGLAND AND UNITED STATES; COMMERCIAL FERTILIZERS AT VIENNA EXHIBITION; CLASSIFICATION OF COMMERCIAL MANURES ON EXHIBITION; INCREASING DEMAND FOR COMMERCIAL MANURES; ANNUAL IMPORTATION OF GUANO INTO ENGLAND, FROM 1840 TO 1861; ANNUAL IMPORTATION OF FERTILIZERS INTO ENGLAND, FROM 1862 TO 1873; USE OF COMMERCIAL MANURES IN THE UNITED STATES.

The demand for these three constituents for plant-food, potassium, phosphorus, and nitrogen, for something which may bring back once more the bountiful crops of the past, has created the business of the manufacture and sale of commercial fertilizers. That the return of these elements to the soil is indispensable to continued fertility in the vast majority of cases may be regarded as settled, since in one way or another this is done in every agricultural section of the world, and it is also beyond question that in those countries where the use of fertilizers has been most extensive, there we find the greatest increase in agricultural productions.

7. IMPORTANCE OF PHOSPHORIC ACID.—The cereal crop of Great Britain annually removes about 92,000 tons of phosphoric acid from her soil, while, to replace this, there is an annual sale of superphosphates amounting to 250,000 tons. If now we estimate the average content of phosphoric acid at 12 per cent., and it is doubtless somewhat above that, we have an aggregate of 30,000 tons of phosphoric acid, or about one-third the amount required by the crop. It must also be remembered that England is a great importer of cereals, the amount equaling one-third of her own production, and the phosphoric acid of which imported cereals is estimated at 31,200 tons annually; and it is by the consumption of these enormous foreign supplies, and the careful preservation of all manurial substances, and their application to the soil, that this annual loss to her soil is not only made good, but that, in fact, the productiveness of English farms has very greatly increased during the past quarter of a century. In the above calculations no account has been made of those constant additions made available in the soil of Great Britain by disintegration, nor of the enormous quantities of guano, ground bones, and other fertilizers, rich in phosphoric acid, to which reference will be soon made.

For the purpose of comparison the following table has been prepared from the latest census-returns, from which the immense agricultural importance of this one constituent of plant-food may be seen:

Countries.	Cereals.		Mineral matter, tons.	Phosphoric acid, tons.
	Bushels.	Tons.		
Great Britain	355, 000, 000	10, 652, 000	286, 000	92, 000
United States	1, 386, 000, 000	35, 580, 000	665, 000	272, 000

8. From the above table it will be seen that the cereal crop of the United States annually removes from our soil 665,000 tons of mineral matters, containing 272,000 tons of phosphoric acid. Were our agriculture carried to as high a level as is that of England, we should return to our grain-lands annually about 740,000 tons of superphosphates of a grade far better than most of those in our markets at present, and increase proportionately our use of all other phosphatic manures.

In the above table it will be observed that the ratios between the total number of bushels, the total weight, and the total mineral matter of the cereals of the United States and Great Britain vary greatly. This apparent error is due to the enormous crop of Indian corn raised in the United States, (over 760,000,000 bushels,) the percentage of mineral matter in which is about three-fourths that contained in other cereals.

9. COMMERCIAL MANURES AT THE VIENNA EXHIBITION.—The exhibition of commercial manures at the Vienna Exhibition of 1873 was quite extensive and both interesting and instructive, showing, as it did, most conclusively, the general interest felt in this important matter, an interest, as manifested by the number and character of the exhibits, nearly in proportion to the material progress of the different nations represented, and affording an approximate standard by which to judge of their relative position in the development of the art and science of agriculture.

The arrangement of articles for exhibition was such, however, as absolutely to preclude any possible chance of comparison, more especially of the products of the various nations represented, and such also as to render the labor of searching out the various articles grouped under one head wearisome not only, but often practically impossible, for not only were different nations assigned distinct quarters in the extensive buildings, but not unfrequently demands for additional space had caused them to overflow into courts, annexes, or separate buildings, so that the difficulties, well-nigh insurmountable to the juryman and reporter who sought faithfully to perform his work, which even the original plan involved, were often multiplied many fold.

Owing also to the various articles on exhibition which would properly fall under consideration in the treatment of this subject, it became necessary to examine a multitude of things arranged under different sections of several different groups. They were, however, chiefly included under the following groups:

Group I, Mining.
Group II, Agriculture.
Group III, Chemical products; and
Section IV, of the additional exhibitions, which was entitled "Waste Materials and Their Products."

But still another and more serious difficulty presented itself in the fact that, so soon as the inspection of the jurymen had ended, one could rarely, if ever, except by special arrangement, find any one in charge of the various collections from whom any reliable information could be obtained, although every courtesy was shown by the officials of the Austrian government, and every facility extended in their power, to render the work of examination complete and satisfactory.

The details of this report are chiefly obtained from printed circulars of information and explanation accompanying many of the exhibits, and from replies received to a circular-letter addressed to the various individuals or corporate exhibitors, requesting information to be embodied in such report, to which circular numerous full and satisfactory responses were given.

10. CLASSIFICATION OF COMMERCIAL MANURES ON EXHIBITION.—The total number of exhibitors under the several heads comprised in the subject of this report was 178, representing 22 nationalities, and giving a total of 240 groups of various matters, as phosphorites, guanos, superphosphates, &c., upon exhibition.

The following tables will show the classification of the various substances on exhibition under these several heads, and their relative proportions, as mentioned in the official catalogue:

	Exhibits.
Artificial manures	103
Bone-meal or flour	32
Superphosphates	27
Phosphorites	21
Guanos	16
Potash salts	11
Dried blood	5
Sulphate of ammonia	5
Fish-manure	5
Ammoniated phosphates	5
Ammonia salts	2
Manures from waste products	4

Under the name of artificial manures were, as will be seen, a large number of exhibits, which a more accurate classification would have distributed chiefly among the other more specific designations given above, but many of them also were fertilizers, interesting as illustrating the utilization of some hitherto waste product of the slaughter-house, the manufactory, or the town, and, although grouped together under

this comprehensive title, they constituted one of the most interesting groups of the entire Exhibition, giving additional evidence of the aid which science is extending to the arts in thus reclaiming and converting into valuable products what have long been counted as utterly waste and often offensive accumulations.

Under each exhibit also many individual specimens were shown, so that the aggregate number of objects properly included under the above heads, and presented to the eye of the observer, were many thousands. Of course, to carry about from day to day, for the purpose of comparison, this vast accumulation, was practically impossible, so that reliance is placed chiefly upon the deliberate written statements of manufacturers, dealers, and exhibitors, or upon the published circulars and price-lists, rather than upon the doubtful recollections of a necessarily hasty survey.

The number of exhibits by the several countries were as follows:

Germany	100	China	5
Austro-Hungary	32	Denmark	4
Italy	15	Uruguay	3
Russia	14	United States	3
Spain	11	Holland	2
Sweden	11	Japan	2
Great Britain	9	British India	1
France	9	Cape Good Hope	1
Norway	8	Egypt	1
Belgium	6	Switzerland	1

The following chart will illustrate the variety of fertilizing materials made use of in the several countries, as shown by the exhibits made, though doubtless through oversight and neglect on the part of many governments taking part in the Exhibition, or through lack of enterprise or appreciation of the extreme importance of this subject on the part of many others, it would be quite erroneous to judge wholly of the relative development of this industry, or of the progress of scientific agriculture, from the number and character of the various exhibits made by the different governments. This is perhaps more especially true of England, France, and the United States, in which countries the manufacture and use of commercial manures has been or is being developed to an enormous extent, wholly disproportionate to the apparently meager exhibition made of these products as shown by the table.

On the part of Great Britain, however, this apparent deficiency was quite unreal, since no exhibits more fully illustrated the magnitude to which, during the past twenty-five years, this department has grown than did those of Edward Packard & Co., of Ipswich, James Gibbs & Co., of London, and the London Manure Company. Indeed, a complete report of the magnificent display made by the first-mentioned exhibitors, E. Packard & Co., would amply suffice to illustrate the entire subject.

matter of this report in nearly all of its varied details. This company claim to have the largest phosphate-mills in the world, and employ in the several departments of labor connected with their immense establishment more than 3,000 workmen, distributed as follows: in France, 1,000; in Germany, 500; in Norway, 100; and in England, 1,500. Their products are chiefly exported to Norway, Sweden, Russia, Spain, Denmark, Germany, France, Mauritius, Ceylon, and the East and West Indies.

In their elaborate exhibition were gathered together systematically-arranged suits of phosphates, coprolites, and fossil-bones, collected from almost every known locality of the world, and from which the various fertilizers are prepared; large collections of all the numerous specimens of fossil-remains associated with these various phosphatic deposits in the several countries, and doubtless intimately related to these deposits and their formation; large photographic illustrations of the various works which this company have established at Ipswich, Bramford, Cambridge, Wetzler, Montauban, giving one an accurate idea of the details of their extended manufacturing and mining operations; and, finally a working model of one of their mills, showing the various machines for grinding and crushing the rock, the mixers and disintegrators, and all the elaborate apparatus of a thoroughly-appointed manufactory, with a full array of samples representing the various products of their manufacture; an exhibition, in short, alike interesting and instructive to the geological student or scientific agriculturist. It was, indeed, this firm who first made practical use of the coprolites of Suffolk in the manufacture of superphosphates.

Countries.	Artificial manure.	Superphosphates.	Ammoniated superphos.	Guano.	Bone-meal.	Dried blood.	Phosphorites.	Gypsum.	Ammonia salts.	Potash salts.	Fish-manure.	Manures from waste.	Total.
United States		1	1	1									3
Great Britain	4			2			1					2	9
Cape Good Hope				1									1
Spain	6			1			2	1		1			11
France	7	1					1						9
Switzerland												1	1
Italy	9			2	1	1			1			1	15
Sweden	4	2		1			3		1				11
Norway	2			1			1				4		8
Denmark	1	1		1			1						4
Belgium	3	1							1	1			6
Holland	1								1				2
Germany	36	15	3	4	24	3	10		1	3	1		100
Austria	13	4	1	1	4	1	1	1	1	5			32
Russia	7	2			2		1		1	1			14
Egypt	1												1
China	5												5
Japan	1							1					2
Hawai				1									1
Uruguay	2				1								3
India	1												1
Total	103	27	5	16	32	5	21	3	7	11	5	4	239

By reference to the table above, it will be seen how large a proportion are placed under the head of artificial manures, due in very many cases to improper classification; but this group included also a large variety of the so-called special fertilizers, prepared and consumed in certain localities for special crops, and adapted rather for the peculiarities of the particular crop and soil, than for general application. Those only will receive special attention in the report which are of general value agriculturally, or which represent peculiarities in their manufacture, or are interesting and valuable as illustrating the economical utilization of some waste material, so as to render their production a matter of general interest and application.

11. INCREASING DEMAND FOR COMMERCIAL MANURES.—Reference has been already made to the enormous extent to which the trade in commercial manures has been developed, but few probably, who have not had their attention directed to statistical information concerning this matter, will not be startled at the astounding proportions to which this business has been carried.

It should be remembered that it is during the past thirty-three years that the manufacture and sale of commercial fertalizers has been developed, since it was only in 1840 that, at the suggestion of Liebig, who wrote that "guano contains not only the mineral elements which a soil must possess to produce corn, but also ammonia, an indispensable element of food, which serves to quicken their action and shorten the time required for their assimilation," in the same year that this same eminent authority suggested the manufacture of superphosphates by the use of sulphuric acid, a process which two years later was in England patented by J. B. Lawes. In 1840 there were imported into England 20 casks, followed in 1841 by an importation of 2,881 tons of guano, and from that time forward the importations have been as follows:

12. ANNUAL IMPORTATIONS OF GUANO INTO GREAT BRITAIN.

	Tons.		Tons.
1842	20,398	1852	129,889
1843	30,002	1853	123,166
1844	104,251	1854	235,111
1845	283,300	1855	305,061
1846	89,203	1856	200,000
1847	82,392	1857	288,362
1848	71,414	1858	353,541
1849	83,438	1859	84,122
1850	116,925	1860	141,435
1851	243,014	1861	152,961

The above statistics, which show an aggregate importation for the first twenty years of 3,137,985 tons, represent but a part only of this vast interest, for it must be remembered that along with this immense importation of guanos, marked as will be seen by four seasons of great

fluctuation, there has been growing up all along, and contemporaneous with it, an enormous and very steadily increasing demand for other fertilizing materials, as bones, fish-pomace, coprolites, apatites, gypsum, soda-niter, potash salts, ashes, &c., while at the same time, the manufacture and sale of superphosphates has developed to such an extent as to have been estimated to reach an annual aggregate of 250,000 tons.

Through the courtesy of the statistical and commercial department of the Board of Trade of Great Britain, I am enabled to give a table of statistics, officially indorsed, representing the quantities and values of bones, guanos, and unenumerated manurial substances imported into Great Britain in each of the last ten years ending with 1872, together with the average prices thereof, by which the table above given will be fully supplemented, as also giving the amount of money involved in this rapidly growing department of trade.

13. QUANTITIES AND VALUE OF BONES, GUANO, AND MANURES UNENUMERATED, IMPORTED INTO THE UNITED KINGDOM IN EACH OF THE LAST TEN YEARS, AND AVERAGE PRICES THEREOF.

Years.	Bones of animals and fish for manure only.			Guano.			Unenumerated.	
	Quantity.	Value.	Average price.	Quantity.	Value.	Average price of Peruvian.	Quantity.	Value.
	Tons.	£	£ s. d.	*Tons.*	£	£ s. d.	*Tons.*	£
1863	65, 404	348, 425	5 6 7	233, 574	2, 658, 856	12 8 3	3, 790	17, 465
1864	60, 828	345, 369	5 13 7	131, 358	1, 457, 088	12 0 0	6, 614	74, 466
1865	65, 642	362, 624	5 10 6	237, 393	2, 675, 995	12 0 0	8, 025	49, 598
1866	72, 878	356, 853	4 17 11	135, 697	1, 439, 679	12 0 0	5, 182	28, 674
1867	73, 262	368, 981	5 0 9	192, 308	2, 109, 506	12 0 0	1, 978	12, 208
1868	70, 546	381, 618	5 8 2	182, 343	2, 039, 478	12 3 0	2, 356	9, 372
1869	90, 604	546, 645	6 1 0	210, 010	2, 640, 983	12 19 0	5, 826	18, 454
1870	92, 032	591, 701	6 9 0	280, 311	3, 476, 680	13 6 0	22, 500	73, 983
1871	92, 878	596, 266	6 8 5	178, 808	1, 986, 986	....	80, 264	276, 949
1872	97, 644	642, 813	6 11 8	118, 704	1, 201, 042	....	131, 936	420, 739

An examination of the above table shows, during the past ten years, a steady increase in the amount of bones imported, along with a steadily advancing price per ton; on the other hand, although the amount of guano imported is very great, it shows very great fluctuations, and during the past four years has fallen off greatly.

The column giving the unenumerated manurial materials is interesting, as showing, by its very rapid increase during the past few years, a successful search after new supplies from sources which, but for this great demand, would have remained undiscovered.

14. USE OF COMMERCIAL MANURES IN THE UNITED STATES.—In the United States the introduction of commercial manures was much later, and their use has been chiefly confined to New England and the States of the Atlantic seaboard, but even here the annual consumption has been estimated to reach over 100,000 tons of superphosphates alone,

(an estimate, doubtless, far too low,) and the quantity is very rapidly increasing.

Prof. S. W. Johnson, in his report upon the Agricultural Experiment Stations of Europe, states that single towns in his State (Connecticut) expend annually $30,000 to $50,000 for guano, superphosphates, &c., besides using large quantities of home supplies.

Hon. Thomas P. Jones, commissioner of agriculture of the State of Georgia, in a circular, has tabulated the results of the analyses of *one hundred and twelve* brands of fertilizers sold in that State. During the season ending May 1, 1875, he states that 48,648 tons of these various compounds were sold in Georgia, at an average of $51 per ton, and amounting to $2,481,048.

That this rapid growth in the use of commercial manures is justified by experience in Great Britain, on the continent, and in our own country, there can be no doubt, since in numberless instances lands long since exhausted by continued cropping have, by their judicious use, been brought once more to their original fertility, while many fields giving scant returns to the agriculturist have been made to produce unprecedented crops.

Hon. S. L. Goodale, late secretary of the Maine Board of Agriculture, and himself engaged in the manufacture of superphosphates, in a lecture upon this subject, has stated the case most clearly in these words:

"Now consider that the trade in commercial manures has grown to its present magnitude under the patronage of farmers alone; that these large amounts are bought, and used, and paid for by a class of men who are habitually cautious about introducing new ways into their practice, averse to parting with money except for value received, and are as capable as any other class of judging whether they get money's worth for money. I do not say that a farmer may not be cheated as easily as another man for once, but to believe that farmers, as a class, for a series of years will continue to pay out money in sums larger and larger every year for what does not give satisfaction, I can no more believe than that five and five are equal to forty. Do not the facts rather prove that so much of this as has been skillfully and honestly manufactured must have been very good and very profitable at the price it bore? How else, by any possibility, could the trade be sustained, and exhibit a steady growth under the accumulated odium of all the frauds connected with it?"

CHAPTER III

NATIVE PHOSPHATES.

COPROLITES OF ENGLAND; PHOSPHATES—SOMBRERO, NAVASSA, ST. MARTIN'S, PACIFIC ISLANDS, FRENCH, SPANISH, GERMAN, CANADIAN, SOUTH CAROLINIAN, RUSSIAN; ANALYSES OF RUSSIAN PHOSPHATES; ANALYSES OF VARIOUS PHOSPHATES; PRICE OF PHOSPHATES—RAW, GERMAN, SPANISH, FRENCH; RAW PHOSPHATES IN THE UNITED STATES.

Of the natural phosphates, the raw material which, manufactured, has served to supply the enormous demand for commercial manures, the exhibition was very complete and satisfactory, every known locality in the world, from which these products are obtained in any quantity, being represented; coprolites from Suffolk, Cambridge, Buckingham, and Bedford Counties, in England; rock guanos, from Sombrero, Navassa, and other deposits of the West Indies; phosphorites from France, Spain, Germany, Upper Canada, and South Carolina. The characteristics of these several varieties are such as to enable one easily to distinguish between them, and their mode of occurrence geologically is such as to render it extremely probable that in most cases they represent the organic life of the period during which the rocks containing these deposits were being formed.

15. COPROLITES OF ENGLAND.—The coprolites or fossil exuviae of extinct reptiles are found principally in the Cretaceous and Tertiary rocks of England, and are generally intimately associated with fossil remains. The quantity of these annually procured from these several deposits in England is estimated to be upward of 200,000 tons, and they are used principally in the manufacture of superphosphates.

The most famous of these several deposits, as being the first developed to any extent, and which may be regarded as typical of this peculiar class of mineral stores, is that of Suffolk. The Suffolk coprolites occur in what is known as the Red crag, one of the Pliocene strata, which consists of a deposit of quartzose sand intermixed with comminuted shells, and of a dark-red color, from the presence of ferruginous matter. These phosphatic nodules are associated with sharks' teeth of remarkable size, and other abundant evidences of the animal life of that age.

The *Cambridge Coprolites* belong to a somewhat earlier geological period, being assigned to the Cretaceous formation, and occurring in what is termed the greensand strata of that formation. They are found at varying depths in this greensand, and occur in lumps of all

sizes, from mere grains to nodules of from three to five pounds weight. These nodules are externally of a peculiar green color, resembling much the color of the sand, possess a rough and uneven though not an angular exterior, and are associated with fossil remains of a character totally different from those which characterize the nodules of the Suffolk crag. *Terebratula*, (a species of *Brachiopoda*) are quite numerous, as also are large numbers of many of the species of the *Cephalopoda*, as *Ammonites*, *Belemnites*, *Hamites*, *Baculites*, *Turrillites*, &c.; showing how abundant was the organic life of that period, which, during its existence as also in its destruction, contributed to these valuable deposits of mineral phosphates.

The *Bedford coprolites* occur in rocks geologically earlier than either of the preceding deposits mentioned, belonging, as is supposed, to the earlier series of the oolitic group. It is found also that the fossil remains of these coprolite-bearing strata represent quite a distinct type of organic life, in strong contrast with the associated remains of these other and later deposits. The phosphate is found in lumps of various sizes, of yellowish-brown color, and the nodules almost invariably representing a greater or less approach to roundness. The action of water upon them is quite marked, and they are to a great extent perforated by a species of stone-borer. The associated fossil remains comprise a few specimens of the *Terebratula*, but the entire mass of phosphatic material appears to be almost wholly composed of remains of *ammonites nodosus*, so much so, that it has been said that the Bedford Coprolite may be considered as a vast cemetery of this particular species of *Cephalopoda*.

16. SOMBRERO PHOSPHATE.—This small island, about two miles long by one-half a mile wide, situated about one hundred and fifty miles east of Porto Rico, in the West Indies, is of coral formation, and contains a vast deposit of phosphate rock, which has probably been derived from phosphatic deposits and organic remains upon the surface, which have through ages leached into and permeated and chemically changed the mass of coral beneath. The appearance of the rock is such as to have led some to the supposition that the mass has at some time been subjected to intense volcanic heat, causing it often to resemble a mass of molten or of semi-liquified matter.

17. NAVASSA PHOSPHATE is imported from the small volcanic island of Navassa, also in the West Indies, about eighty miles east of Jamaica. This phosphate is of peculiar form and character, closely resembling a compacted oolitic mass, of a dark-brown color. This oolitic character is so marked, that one could readily imagine this phosphate to be a mass of roe, even the larger masses by rubbing separating readily in distinct spherical grains. Since the formation of this deposit it has evidently undergone changes, possibly of a volcanic character, so that every trace of organic life has been destroyed. The same is to a great extent true of the Sombrero deposits, although there remains of coral and of other animal life are frequently found, but generally so changed as to render

identification difficult or impossible. The Navassa deposits are among the richest and most valuable known.

18. St. Martin's phosphate, from an island of that name nearly due south from Sombrero, has latterly been imported to a great extent, and, as the analyses will show further on, is of an excellent quality.

19. Pacific Ocean phosphates.—Phosphates have been found in great quantity, and imported chiefly by the European manufacturers, from several of the smaller islands of the Pacific, prominently among which are to be mentioned Baker's, Howland, Jarvis, Malden, Enderberry, &c., and the commercial value of these several products, as shown by analyses, will be hereafter noticed.

20. French phosphate.—The occurrence of the rich deposits of England soon led to the search after similar beds throughout the similar geological formations of Northeastern France, and subsequently throughout the entire empire, and the result has been the discovery of many valuable deposits, chiefly those in the departments of Ardennes, Marne, and Meuse, in Northeastern France, and those in the southwest, in the departments of Bordeaux, Tarn, and Garonne. The nodules of the first-mentioned district differ not widely from similar phosphates already described as so abundant in England. Their form is always slightly rounded and irregular, their size varying from that of a hazel-nut to a man's fist; and occasionally they are found cemented together into masses many kilograms in weight. Their color also varies from a gray ocherous tint to a dark green. To the practiced eye their physical characteristics, of specific gravity, hardness, and color, will give one the means of judging with great accuracy of their relative richness.

The phosphate of the southwestern departments is in appearance much like that from Sombrero, already described. It frequently occurs in masses of twenty pounds weight, and much of it occurs in layers or flakes, as though deposited in successive strata, while other specimens appear banded like agate, or present the appearance of chalcedony, as though the mass had been subjected to complete or partial fusion. It is unassociated with fossil remains, but is supposed to belong to the Miocene formation.

There exists still another apparently quite extensive deposit in Eastern France, upon the banks of the Rhone, near Geneva. This deposit is estimated to extend over a territory of about 1,000 hectares, 500 of which are available for working, and the estimated amount of the phosphate contained in this workable section is about 9,000,000 tons.

21. Spanish phosphate.—The phosphate deposits of Spain, thus far worked to any extent, exist in the province of Estrémadura, near Caceres, whence the mineral is transported to Merida, thence by railroad to Lisbon, whence it is shipped to foreign markets, chiefly England and Germany. The quality is excellent, and this phosphate is in great demand, despite the expense of long transportation and frequent reshipment. Other deposits of phosphates have been discovered in the district

of Malpartida, others still at Trujillo, Alcantara, Zarza la Mayor, Logrosan, and several other places, although the extent of these has not been, as yet, determined.

22. GERMAN PHOSPHATES.—In the province of Nassau, Germany, on the banks of the Lahn, a tributary of the Rhine, have been found numerous deposits of phosphorite, and already in some fifteen or twenty localities mines are in successful operation. The average product, however, of the rock is not very high, the raw material being divided into assorted lots of varying degrees of richness from 25 to 70 per cent. of calcic phosphate.

Recently, also, a deposit of coprolites has been discovered near Helmstedt, in Brunswick, which has already yielded considerably and promises well for the future. This deposit, like that of several other of the coprolitic beds already mentioned, is associated with greensand.

23. CANADIAN APATITES.—The phosphates from Canada are found in the metamorphic Laurentian rocks and distributed very abundantly throughout various localities in the townships of Burgess and North Elmsley, in the province of Ontario, apparently existing in very great quantity, and, during the past three or four years, mined to a great extent; the products of these mines being in part shipped to England, and in part manufactured at the Brockville Chemical Works into a superphosphate of lime of a high grade and of an excellent quality.

This phosphate appears to be quite unique in its occurrence, having nothing of the nodular or concretionary character of that from other deposits, being entirely unassociated with organic remains, and with no evidence of such an origin; but being, on the other hand, highly crystalline, and frequently occurring in large and well-defined crystals; and although, as yet, further explorations may be necessary in order to settle this question, it appears to be formed in well-defined veins. It contains an appreciable quantity of fluorine, (2 to 4 per cent.,) and, al though associated with other minerals, often most intimately, there are many localities where the phosphate may be readily obtained in quantity of a very high grade, containing as high as 80 to 90 per cent. of calcic phosphate.

24. SOUTH CAROLINA PHOSPHATES.—During the past few years public attention has been called to the nodular deposits, for a long time known, and found in many localities, and in great abundance in what was called the fish-bed of the Charleston basin. These marl stones, as they were termed, or as they have proved to be phosphate nodules, very similar in character to those found in many of the European deposits, are found most abundant along the Ashley, Cooper, and Wando Rivers, which empty their waters into the Charleston Harbor, and later investigations have proved their existence in numberless deposits extending in a southwesterly direction, parallel with the coast as far down as Port Royal, along the banks of the Edisto, Stono, Coosaw, Ashepoo, and Combahee Rivers, and comprising an area of several hundred square miles.

The following particulars concerning this large and valuable deposit are obtained chiefly from the published accounts of Professors Shepherd, junior and senior, and Dr. N. A. Pratt, of Charleston:

The nodules vary in size from small pebbles to masses several hundred pounds in weight, varying in specific gravity from 2 to 2.5. They are often found abundantly distributed over the surface to such an extent as to seriously interfere with the cultivation of the land; at other points they occur sparingly scattered about, while at other points along the beds of the Ashley, Cooper, and Ashepoo Rivers, the nodules lie compactly together forming an immense pavement from two to six feet below the surface and extending over hundreds of acres. This bed or pavement is from 9 to 12 inches in thickness, with a smooth and glazed upper surface, but irregular beneath, and especially on the latter river overlies a bed of nodular phosphates of smaller size and extending 12 to 15 inches below the continuous stratum or pavement above.

Upon the Ashley River, where the beds were first discovered, and where they are most conveniently and most extensively mined, the nodules are of a yellowish-gray color, of but slightly irregular surface, and of a pretty constant composition. They occur in a light soil, generally within two feet of the surface, and are readily freed from adhering earth. Upon the Ashepoo River, where the continuous pavement above mentioned occurs, the nodules are imbedded in a tenacious clay, which in turn rests upon a yellowish red marl. This marl abounds in shells and the bones of marine and land animals, and contains from 5 to 7 per cent. of phosphates of lime, alumina, and iron. The fossil remains show the deposits to belong to the Eocene period. The nodules themselves are often perforated by boring shells, in a manner similar to those found in the Suffolk Crag of England; and as in the crag, so also in these Charleston beds, the teeth of extinct species of sharks abound, some of which are of enormous size, individual teeth having been found weighing from 2 to 2½ pounds.

Quite recently Professor Shepherd has described a deposit of phosphatic sand overlying the nodular deposit upon Stono River, and resulting from the wearing away of this nodular bed, this sand deposit being in places some six feet thick, an analysis of the dried sand giving 27 per cent. of calcium phosphate, the remainder being mostly an impalpable sand with slight admixture (less than 3 per cent.) of carbonate of lime, much of which by washing would be removed, leaving a residue containing 37 per cent. of phosphate. According to Professor Shepherd this deposit of sand appears to be very extensive, and although hardly rich enough to warrant exportation so long as the richer nodular deposits exist in such abundance, it is nevertheless admirably adapted for home use, for which purpose he strongly commends it.

The amount of phosphate rock taken out from the various deposits of South Carolina, from the year 1867 to July, 1872, is officially stated to have been 242,415 tons.

25. RUSSIAN PHOSPHATES.—Quite recently there have been discovered also a remarkable series of deposits of phosphates in Central and Southeastern Russia, which appear to exist in three zones of very considerable extent, the central zone comprising the provinces of Smolensk, Orel, Koursk, and Woronège, an extent of country four hundred miles in length, and in breadth varying from ninety to one hundred and twenty-five miles.

These deposits belong to the Cretaceous formation which in Central Russia forms a sort of basin, of which thus far only the northern side has been explored in detail. But it appears to be at this northern limit of the Cretaceous where the rocks of this formation give place to the Jurassic and Devonian rocks, where these rich deposits have been discovered. This section has been carefully studied by Al. S. Yermolow, of St. Petersburg, to whose report, made to his government, I am indebted for these interesting facts and statistics concerning these valuable and extensive deposits.

The section along the banks of the Volga has also been studied by Professor Barbot de Marny, of St. Petersburg, while those deposits upon the banks of the Niemen, in Western Russia, have been examined by Professor Gréving, of Dorpat, and finally a thorough examination of the mineral phosphates of Podolie, in Southwestern Russia, has been made by M. Schwakhofer, of Vienna.

These several investigators have revealed the presence of an almost exhaustless supply of this valuable rock, underlying many millions of acres in Central and Southwestern Russia. These deposits, although found for the most part in the Cretaceous rocks, do not apparently belong to any particular geological age, since they occur in the Jurassic, Tertiary, and even in the Silurian also. In the Cretaceous, the phosphate occurs generally as subordinate layer or layers in the chalk; at other times, it is found imbedded in a mass of greenish sand containing grains of glauconite. At other times, these phosphatic nodules are found distributed in greater or less abundance through the soil; sometimes also disseminated as nodules through the chalk or marl, while more rarely the bed for these deposits consists of argillaceous schists.

The various deposits apparently indicate that their origin is due to the solvent action of waters charged with carbonic acid, filtering through these calcareous beds, and acting upon the various organic and other phosphatic materials, of which, in fossil remains found in these beds, there is abundant evidence, more than fifty distinct species having been determined, including fishes, saurians, and coprolites. At other times their occurrence points to displacement through the action of water, the detached bowlders having evidently been removed from the place of their origin and transferred through the agency of water. The number of these phosphatic layers varies generally from one to three, though sometimes as many as seven are found, but of these, only one or two are of sufficient thickness to be of practical

value. The thickness of these layers differs widely, but is from six to twenty inches usually. The depth at which they are found is also quite variable; at one time these deposits being at the very surface, at another several hundred feet below. It is, however, worthy of remark that along the border of this phosphatic zone the layers of phosphate rise to the surface, while toward the center of the zone they are found at much greater depths.

The form of the phosphate is likewise inconstant; generally occurring in nodules of variable size and color, black, brown, gray, or green; sometimes, (as in the neighborhood of Koursk, Woronège, and Tambow, for example,) the phosphate occurs in slabs or flags, assuming the appearance of massive blocks, almost resembling piles of cut stone, but which, upon closer examination, prove to be only an agglomeration of bowlders held together by a sort of cement. It is generally in this latter form that the phosphate nodules have been used for paving—the scattered nodules being softer, and up to the present having been regarded as of no especial value.

Besides this central zone, which has been described somewhat in detail, there occur the beds of the eastern zone, viz, those of Tambow, Spassk, Simbirsk, and Saratow; and those of the southwest, comprising the districts of Grodno, Podolie, and Kiew.

The aggregate amount of phosphate contained in these several deposits seems almost fabulous, it being estimated that the central zone, comprising the districts of Smolensk, Orel, Koursk, and Woronège, contains no less than 15,000 to 20,000 tons of mineral phosphate to the hectare, (about 2½ acres;) while those deposits about Tambow, which are more abundant and richer in phosphoric acid, as shown by analyses, would furnish two or three times the above quantity, or 30,000 to 60,000 tons to the hectare. Allowing but 350 pounds of phosphoric acid, equal to 770 pounds (39 per cent.) of phosphate of lime to the ton—and in fact a vast number of analyses show the rock to contain almost invariably more than this estimate—the above calculation would give from 4½ to 9 tons of pure phosphate of lime to the acre. This calculation embraces only those principal deposits mentioned, taking no account of the immense quantity of phosphates present in those districts where a less thorough examination has been made, but where preliminary surveys have shown the existence of deposits which must swell the aggregate to enormous proportions. Indeed, as M. Yermolow concludes, "We prefer to pause here without carrying our calculation further, for fear of being charged with exaggeration."

Analyses of these phosphates, from the several localities mentioned, show them to be in composition not inferior to many other phosphates, and there seems little reason to doubt but that the increasing demand for this valuable constituent will be, in part at least, supplied from these apparently exhaustless stores, and that perhaps as soon as these deposits are made readily accessible, through better means of transportation,

the prices of this raw material and of the manufactured products may decline even with an increasing demand.

A glance at the results of numerous analyses of these phosphates will suffice to convince any one that there exist in European Russia the means of restoring and maintaining the productiveness of the soil of Europe, so far as this invaluable constituent of plant-food is concerned, for ages to come, and it can only be a question of time, and that short, when these vast deposits are rendered available to European agriculture. A valuable feature in the composition of these several phosphates is, first, their large amount of phosphoric acid; secondly, the small amount relatively of carbonate of lime, iron oxide, and alumina, the remaining percentage of the phosphate rock, after deducting the calcium phosphate, being principally insoluble sand-grains or silica.

26. ANALYSES OF RUSSIAN PHOSPHATES.

	Locality.	Number of analyses averaged.	Phosphate of lime, per cent.	Phosphoric acid, per cent.
Phosphate rock	Roslawl	6	45.49	21.11
Do	Briansk-Orel	9	36.32	16.76
Do	Koursk	8	38.72	17.86
Do	Woronège	9	36.13	15.66
Do	Tambow	7	44.04	20.14
Do	Spassk	10	47.40	21.70
Do	Podolie	8	74.48	34.13
Do	Nijni Novgorod	2	59.55	27.50
Do	Grodno	2	37.44	17.15
Do	Moscow	1	36.11	16.55
Dried mud from streets or highways paved with nodules	Various	9	13.24	6.08

27. ANALYSES OF VARIOUS PHOSPHATES.—In the following table are given the analyses of several commercial phosphates from various localities heretofore mentioned, representing the average composition of entire cargoes imported by Emil Güssefeld, of Hamburg, an extensive dealer in these products:

	Percentage of phosphate of lime.	Percentage of phosphoric acid.
Baker Island guano	73.43	33.64
Howland Island guano	70.51	32.30
Enderberry Island guano	81.67	37.41
Malden Island guano	79.29	36.32
Jarvis Island guano	84.84	38.86
St. Martin's Island phosphate	84.46	38.69
Estrémadura phosphate	81.82	37.48
South Carolina phosphate	60.34	27.64
Mexican phosphate	90.53	41.47

28. PRICE OF RAW PHOSPHATES.—The market-price of the various mineral phosphates depends, of course, primarily upon the purity of the

mineral, although not quite in proportion to the percentage of phosphate contained in the various specimens, owing in part to the fact that the presence of other mineral impurities, more especially the carbonates, is a source of very considerable loss of sulphuric acid in the manufacture of superphosphates, for which purpose these raw phosphates are chiefly used, and in part also to the proportional increase in cost of transportation. It also happens, as has been already observed, that in nearly every locality, along with the richer deposits, there are found others of almost every grade, so that, while for the better qualities of phosphates the demand is pretty constant, and prices firm, comparatively, the supply of the poorer grades is generally in excess. The subjoined price-list of Messrs. Müller, Packard & Co., of Limburg, Germany, will illustrate this point, as also give an idea of the ruling prices for this mineral abroad:

	Percentage of phosphate of lime.	Percentage of phosphoric acid.	Price per ton of 2,000 pounds.
Phosphate, unground	25	11.45	$2 00
Do	30	13.74	3 00
Do	35	16.03	4 00
Do	40	18.32	5 00
Do	45	20.61	6 00
Do	50	22.90	7 60
Do	55	25.19	9 00
Do	60	27.48	11 60
Do	65	29.77	14 00
Do	70	32.06	17 60

In a fine powder the price is $2.50 per ton additional, and for sacks $1.25 per ton additional to the above prices.

Messrs. H. & E. Albert, of Biebrich on the Rhine, very extensive manufacturers and dealers, whose sales aggregate about 25,000 tons of phosphorite annually, furnish me the following price-list of the Lahn phosphorite:

29. PRICE-LIST OF H. & E. ALBERT, BIEBRICH, NASSAU, OF LAHN PHOSPHORITE.

	Percentage of phosphate of lime.	Percentage of phosphoric acid.	Price per ton of 2,000 pounds.
Raw phosphorite, unground	25	11.45	$1 00
Do .... do	30	13.74	2 00
Do .... do	35	16.03	3 50
Do .... do	40	18.32	5 00
Do .... do	45	20.61	6 00
Do .... do	50	22.90	7 60
Do .... do	55	25.19	9 00
Do .... do	60	27.48	11 60
Do .... do	65	29.77	14 00
Do .... do	70	32.06	17 60

The charges for grinding and sacking are the same as those already given. It will be observed, however, that the prices of this latter firm

are considerably less for the lower grades of phosphates, up to that containing 40 per cent., for which grade and for the higher ones the prices are the same with both houses.

30. PRICE OF SPANISH PHOSPHATE.—The circular issued by the company controlling the phosphate mines of Estrémadura, Spain, states the price of the raw mineral at the mines to be 40 reals per ton; the transportation from Caceres to railroad at Merida to be 25 to 40 reals per ton, according to season, and by railroad from Merida to Lisbon 91 reals per ton; so that the price of the mineral at this latter port varies from $16 to $22 per ton. This company are at present operating mines of phosphate at the following places, all lying within the district of Caceres, in the province of Estrémadura, viz: Esmeralda, Estrella, San Salvador, San Eugenio, Perla, and Lucero. The product of these mines varies in composition, as shown by analyses, from 53 to 86 per cent. of phosphate of lime, equal to 24 to 40 per cent. of phosphoric acid.

31. PRICE OF FRENCH PHOSPHATE.—The phosphate-beds of Northeastern France, in the departments of Ardennes, Marne, and Meuse, yield a product of varying composition, and of nearly every condition as to purity; but, for the purpose of commercial convenience, the various products have been divided into four classes of the composition and prices annexed.

Price-list of Desaille of Grandpré, (Ardennes.)

		Percentage of phosphate of lime.	Percentage of phosphoric acid.	Price per ton of 2,000 pounds.
No. 1	Phosphate	62 to 70	28.40 to 32.06	$14 00
2	......do	52 to 58	23.82 to 26.56	11 60
3	......do	46 to 50	21.07 to 22.90	10 00
4	......do	40 to 45	18.32 to 20.61	9 00

In the mines of this company more than four hundred workmen are in constant employ, and the annual yield of mineral phosphate is many thousand tons, all of which is given up to agricultural uses. The deposits in the vicinity of Montauban, in Southwestern France, yield a phosphate, as already described, of a physical character quite distinct from that of the northeastern districts, and containing a much higher percentage of phosphate of lime. The analyses show over 70 per cent. of pure phosphate, equal to over 32 per cent. of phosphoric acid, and the price at Bordeaux averages about $20 per ton. Messrs. Packard & Son, of Ipswich, England, employ about one thousand men in the mines of this section, and the exhibits they made of the phosphates from these mines were unsurpassed in quality.

32. PRICES OF RAW PHOSPHATES IN UNITED STATES.—The principal resources of our manufacturers for their supplies of phosphoric acid are the South Carolina and Canadian phosphates, bone-black refuse, and Navassa phosphates.

Prof. C. A. Goessmann, of the Massachusetts Agricultural College,

State inspector of fertilizers, in his second annual report, gives the following table of prices to several of the above phosphates:

Market.	Name of phosphates.	Percentage of phosphate of lime.	Percentage of phosphoric acid.	Price per ton of 2,000 pounds.
Charleston	South Carolina	54.56	25.00	$7 50
Boston	do	54.56	25.00	11 50
Do	South Carolina, ground	54.56	25.00	13 50
New York	Navassa, ground	65.70	30.10	16 00
Boston	Bone-black refuse	72.75	33.32	25 00

The Canadian apatite containing a guaranteed amount of phosphate of lime, of from 80 to 90 per cent., equal to 36.64 to 41.22 per cent. of phosphoric acid, may be bought at points convenient for shipment for from $12 to $14 per ton. The expenses of foreign shipment have thus far prevented the development to a great extent of this important and extensive supply of a mineral phosphate excelled by none in the world in its purity and high grade.

Whenever the use of superphosphates or other phosphatic manures shall have reached an extent at all comparable with what exists at present both in England and upon the Continent, especially in Germany, and the demand for these raw phosphates shall exceed the present home supplies, there is no doubt but that by direct importations from those deposits mentioned, at present almost exclusively monopolized by foreign nations, we shall see landed upon our wharves, at prices not far above those above quoted, an abundant supply for our use.

At the present, however, these foreign markets are open to us, and it has been found practicable to compete with the present ruling prices of our home manufactures by the importation of English and German fertilizers. Mr. Henry Saltonstall, treasurer of the Massachusetts Society for Promoting Agriculture, from results of an experimental importation of superphosphates from London and Bonn, the full account of expenses for which is published in the Bulletin of the Bussey Institution, has made a careful estimation of the entire expense of importation from London and Hamburg by sailing-vessels direct, in which expenses are included barrels for packing, shipping-charges, consuls' fees, commission, freight, primage, customs fees, wharfage, and gold premium, indeed everything which would necessarily involve the importer in expense, from which it appears that for lots of ten tons the cost of importation from London to Boston would be $13.85 in currency per ton, and from Hamburg to Boston $15.37 in currency per ton.

Obviously, the freight and primage charges included in the above estimations (25 shillings = $6.87 from London, and 30 shillings = $8.25 from Hamburg, per ton) is far above what would be charged upon large shipments, but even at these prices, as will appear, the result of importation is most satisfactory.

CHAPTER IV.

MARKET VALUE OF FERTILIZERS.

PRICE OF SUPERPHOSPHATE—GERMAN, ENGLISH; PRICE PER POUND OF SOLUBLE PHOSPHORIC ACID; ANALYSES OF AMERICAN FERTILIZERS; AVERAGE COMPOSITION OF AMERICAN FERTILIZERS; RATIO OF PRICE TO VALUE IN AMERICAN FERTILIZERS; FRAUDS IN MANUFACTURE AND SALE OF FERTILIZERS; PREVENTION OF FRAUDS.

As we might suppose would be the universal practice, and indeed as is, both in England and upon the continent, almost universally the case, commercial fertilizers are sold at prices corresponding to their intrinsic value, as determined by the amounts of the constituents of plant-food, (phosphoric acid, potash, and ammonia,) which these fertilizers severally contain, and for which, alone, the agriculturist purchases such supplies.

In the United States, however, almost without exception, although the number of fertilizers filling our markets is hundreds, no such graduated scale of prices exists, nor indeed is there at present any very general or intelligent demand for such. It is, indeed, in a general way recognized that unleached and hard-wood ashes are better than leached, ton for ton; that also a phosphate containing 12 to 15 per cent. of soluble phosphoric acid is worth somewhat more than one not having more than 3 to 5 per cent., and latterly, indeed, considerable comment has been made at the falling off in real value in what was once considered almost a standard by which to estimate the relative worth of other fertilizers—Peruvian guano; but the general rule has been that the chemical composition, with all its accuracy in determining market value, or the results in producing crops, with all the uncertainties which surround this means of estimating value, in the case of any particular fertilizer, has had far less influence in determining the amount of its sales or its market value than the local reputation of the manufacturer, or the persistent advertising of his product. This fact is hardly due to any fault of the agricultural press of the country, though it must be confessed that as a rule it represents rather than leads the general thought; but it is due rather to a general want of intelligence among the people concerning this vital matter in agriculture. It is due also in great part to the fact that among the host of various fertilizers there are few indeed absolutely worthless, and in the thousands of experiments annually made with them, it often happens that other favoring conditions conspire to bring about wonderful results, which have been attributed wholly to the use of some given fertilizer, the manufa

turer or agents of which have through pamphlet and circular and flaming advertisement, published and continue to publish such results to the world, ignoring often, and indeed generally, the records of results less flattering, which have been secured by their patrons.

So great has been the ignorance among our American farmers as to the fundamental principles of plant-growth, that the field has been a fruitful one to the knaves, and our markets have been filled with many so-called fertilizers, which, not only worthless, or nearly so, in themselves, have, while defrauding the farmer of his money, caused him far greater injury in wholly undermining his confidence in scientific agriculture. Obviously the only thorough remedy is in increased intelligence; but until this is brought about the only safe method will be for the farmer to purchase only such fertilizers as have an established reputation, and the manufacture of which is under the control of those competent for the work.

Having decided what constituent he wishes to add to his soil, the intelligent farmer will secure it at the lowest market price, remembering that, as with other products of the market, the several constituents of every good fertilizer have a definite commercial value, subject only to such fluctuations as affect the prices of other commodities.

In several of our States the manufacturers and dealers are compelled by law to affix to each package of their fertilizer a label showing plainly the constituents present in the fertilizer, and the percentage of each valuable constituent; and in case the article sold fails to answer this analysis, legal damages may be recovered from the seller. Some such law it is important should exist in every State, as it would prove, alike to the honest manufacturer and consumer, a protection from the ignorant or the unprincipled, who at present suffer only in a decreasing demand for their wares, so soon as their true character becomes known. The non-existence of such laws upon our several statutes illustrates perhaps better than anything else how ignorant, rather than unmindful, our people are of this very important interest.

With such a law in force, desired as it is by every honest and intelligent manufacturer and consumer, and in many States already secured by their united and persistent efforts, the purchaser would have no difficulty in securing what he wished, and buying it as intelligently as he would any other product in the market. It is earnestly to be hoped that the time will soon come when our crops shall be as judiciously fed as our stock, and when the conditions favoring the complete development of wheat and corn and clover shall be as well known and in practice as rigidly observed as are those relating to the growth of horses, sheep, and swine. From generation to generation certain practices have obtained in agriculture, a certain routine has been followed, and success more or less marked has resulted; but as regards an accurate knowledge of the fundamental principles involved, it must be confessed that very few of our farmers are advanced much beyond those who cultivated the fertile valleys of the Nile in the days of the Pharaohs.

That indeed this state of affairs is not wholly unique in the agricultural world, but is, even in sections the most fertile and in districts devoted to agricultural pursuits for many centuries, sometimes lamentably true, may be learned in a few sentences from a letter received from a gentleman of Treviso, near Venice, who thus testifies as to the agricultural condition of that section: "In this province there are very few landed proprietors who are themselves interested in agriculture, but they farm out their lands to the laborers themselves, who are, as a class, mere idiots, (cretins,) wretched fellows, whose manners and cultivation conform to the system of Adam. With the exception of a few insignificant experiments, no one here makes any use of artificial manures, this being a matter wholly neglected."

Professor Goessmann, in reference to this matter under consideration, says: "The most important information which the farmer needs to secure to himself the full agricultural value of any commercial fertilizer offered for sale, consists in knowing the exact kind, the amount, and the chemical and physical condition of the essential articles of plant-food it contains; without it a rational system of manuring becomes impossible. Commercial fertilizers are too expensive to be used without a careful consideration as to whether they will bring speedy returns or not. The time when fertilizers and refuse-matter meant the same thing has passed by. The surest way to establish a reputation for a well-prepared fertilizer, which contains one or more of the essential articles of plant-food, next to a reasonable price, is to furnish it of a uniform composition. Reliable, standard fertilizers are needed in the interest of a rational system of manuring and of a good economy."

The market-value of fertilizers should be governed by the value of the various constituents they contain. In the case of nearly all the commercial fertilizers their value depends upon the amounts, respectively, of phosphoric acid, potash, and ammonia they contain, since in these compounds we have those important elements of plant-food,, phosphorus, potassium, and nitrogen. But as the plant can only take up those substances which are soluble it is necessary to take into consideration the condition in which these elements exist. Feldspar contains from 10 to 15 per cent. of potash, but owing to its extreme insolubility it is practically worthless as a fertilizer. So, too, the native phosphates already described, though rich in phosphoric acid, are worthless as plant-food, for, as their natural occurrence sufficiently indicates, they may remain for ages with but little change, but after their treatment with sulphuric acid the phosphoric acid is rendered available to the growing plant through having been rendered soluble. The same may be said of horn, leather-chips, and so forth, insoluble compounds, though rich in nitrogen, but on account of their insolubility of very little value as a means of fertilization.

The following price-lists from many extensive manufacturers in Germany and England will illustrate to what an extent this business of

commercial manures has settled down to the firm basis of what may be regarded as legitimate trade; a basis which has upon the one hand an intelligent demand, met upon the other with an equally intelligent as well as honest effort to afford a supply. From the number of these quotations, purposely numerous that they might not be regarded as exceptional, and representing most of the great markets of Europe, it will be seen how close the agreement in the prices of similar products, how strictly proportional to the percentage composition is the price quoted. Indeed, as is invariably the case with every large manufacturer, from the necessity which competition in business occasions compelling them, if not from choice, they conduct this branch of business upon the same general principles which obtain in others, nor think even to make this an exception to all the various products of their manufactories.

The circular and price-list of the Chemical Manufacturing Company of Oranienburg, near Berlin, gives the following prices of their various superphosphates, calculated to the price in gold, for each ton of 2,000 pounds:

33. PRICE-LIST OF CHEMICAL MANUFACTURING COMPANY, ORANIENBURG, NEAR BERLIN.

		Percentage of nitrogen.	Percentage of soluble phosphoric acid.	Price per ton, 2,000 pounds.
No. 1	Bone-ash superphosphate	....	12–14	$25 09
2	......do	....	14–16	30 73
3	......do	....	16–18	35 27
1	Mejillones guano superphosphate	....	12–14	25 09
2	......do	....	14–16	28 91
3	......do	....	16–18	32 91
4	......do	....	18–20	38 73
1	Bone-char superphosphate	....	12–14	25 09
2	......do	....	14–16	30 73
3	......do	....	16–18	35 27
1	Bone-meal superphosphate	5–6	8–10	45 45
2	......do	2–3	12–14	38 73
1	Ammoniated superphosphate	3–4	10–12	40 91
2	......do	3–4	12–14	42 27

It is to be observed that in all the above there is no mention whatever of "*insoluble*" phosphoric acid, nor even of "*reduced*" or "*reverted*" phosphoric acid. The only kind thought worthy of mention in a *superphosphate* is that which is *soluble in water*.

The circular of the Bavarian Chemical and Agricultural Manufacturing Company, located at Heufeld, in Upper Bavaria, gives the following prices, calculated to gold basis:

Prices at Heufeld, Upper Bavaria.

		Percentage of soluble phosphoric acid.	Percentage of total phosphoric acid.	Price per ton of 2,000 pounds.
No. 1	Superphosphate	19	21	$46 73
2	......do	15	18	38 91
3	......do	6	*15	31 09

* No. 3 contains 4 per cent. of the 15 per cent. in the form of "reduced," and they have, as will be seen, 2, 3, and 5 per cent., respectively, of insoluble.

The price-current of the Union Chemical Manufacturing Company of Magdeburg and Stettin, in Saxon Prussia, gives the following series of products, many of which are highly ammoniated superphosphates. This company is one of the largest in Germany, manufacturing annually from seven to ten thousand tons of fertilizers.

Price-current Union Chemical Manufacturing Company of Magdeburg and Stettin.

		Percentage of nitrogen.	Percentage of soluble phosphoric acid.
No. 1	Bone ash and char superphosphate	....	15 -18
2	......do	....	13½-15
3	......do	....	12 -13
	Baker's guano superphosphate	....	18 -20
1	Baker's guano ammoniated superphosphate	14-15	4 - 5
2	......do	9-10	9 -10
3	......do	6- 7	12 -13
4	......do	4- 5	14 -15
1	Bone ammoniated superphosphate	9-10	8 - 9
2	......do	6- 7	11 -12
3	......do	5- 6	10 -12
4	......do	3- 4	13 -14

In the above the soluble phosphoric acid is counted at $2 for each per cent. contained, and the nitrogen at $5.20 for each per cent. per net ton, so that, for example, a superphosphate containing 15 per cent. of soluble phosphoric acid would cost $30 per ton; or one with 15 per cent. soluble phosphoric acid and 5 per cent. of nitrogen (as ammonia) would cost $56 per ton.

The price-list published by Dr. Julius Bidtel, of Cölln, near Meissen, Saxony, another very extensive German manufacturer of fertilizers, gives the following:

		Percentage of nitrogen.	Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
No. 1	Baker's guano superphosphate	....	19-21	$39 82
2	......do	....	17-18	37 46
3	......do	....	14-16	31 82
	Bone-ash superphosphate	....	17-18	38 18
	Peruvian guano superphosphate	9-10	9-10	70 36
1	Ammoniated superphosphate	8	10-12	67 10
2	......do	6-7	10	59 10
3	......do	4	12	48 90

The annual aggregate of these products exceeds 3,000 tons.

The price-list of the Berlin Bone-Meal Manufactory, of Dr. William Cohn, at Martiniquefeld, near Berlin, gives, among many others, the following quotations:

Price-list of Dr. William Cohn, Martiniquefeld, near Berlin.

		Percentage of nitrogen.	Percentage of phosphoric acid, soluble.	Price per ton of 2,000 pounds.
	Superphosphate	....	17–18	$37 45
	Baker's guano superphosphate	....	19–20	40 91
No. 1	Ammoniated superphosphate	4– 5	14–15	56 91
2	......do	9–10	9–10	75 09
3	......do	4	12	50 00
4	......do	3– 4	*9–10	49 45

*No. 4 contains of reduced and insoluble phosphoric acid about 9 per cent. additional. The above prices include the sacks and the packing. The annual sales of the above products amount to from 2,000 to 2,500 tons.

Mr. Ludwig Michaelis, manufacturer of commercial manures at Glogau, Silesia, has furnished the following statement as to the composition and prices of his products:

Prices from Ludwig Michaelis.

	Percentage of nitrogen.	Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
Superphosphate	......	17	$31 82
Superphosphate ammoniated	4	13	44 36

Messrs. H. & E. Albert, of Brebrich, in Hessen-Nassau, whose sales of superphosphates aggregate 4,000 tons annually, furnish the following price-list of their products:

		Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
No. 1	Superphosphate	10	$25 30
2	......do	12	29 30
3	......do	15	36 90
4	......do	20	44 20
5	......do	25	54 50

Besides the above, they prepare several others of composition differing from those given, some of which are nitrogenized with one or another of the following constituents: ammonia salts, nitrates or gelatine, and others containing potassium salts, either the sulphate or chloride Their scale of prices per ton of 2,000 pounds for these is adjusted upon

the following basis: for each per cent. of phosphoric acid soluble in water, $2.30; for each per cent. of phosphoric acid soluble in ammonium citrate, $1.40; for each per cent. of phosphoric acid soluble in acids, 70 cents; for each per cent. of nitrogen, as ammonia salts, $5.47; for each per cent. of nitrogen, as nitrate, $5.47; for each per cent. of nitrogen, as gelatine, $3.64; for each per cent. of potash, as sulphate, $1.80; for each per cent. of potash, as chloride, $1.13.

Joseph Owens & Sons, of Copenhagen, send the following list of prices for their products, and estimate the annual consumption of superphosphates and other commercial manures in their country as approximating 20,000 tons:

	Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
Coprolite superphosphate	11-12	$20 83
Baker's Island guano superphosphate	20	49 00
Mejillone's Island guano superphosphate	20	46 55
South Carolina superphosphate	12-13	22 05

34. ENGLISH SUPERPHOSPHATES.—The following prices of several leading English manufacturers will enable us to compare the character of their products, as also their current prices, with those of the leading German manufacturers, and a few will suffice:

Messrs. J. & J. Cunningham, of Edinburgh, in their annual trade-circular for 1873 gives the following composition and prices for several of their products:

	Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
Superphosphate from guano	15.51	$34 30
Superphosphate from bone-ash	16.71	31 85
Superphosphate from French phosphate	15.43	29 40
Superphosphate from coprolite	11.02	19 60

Messrs. James Gibbs & Co., of London, offer the following among many other fertilizers:

	Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
Superphosphate	11.56	$17 83
Superphosphate	16-17½	25 27

Odams Chemical Manure Company of London the following:

	Percentage of soluble phosphoric acid.	Price per ton of 2,000 pounds.
Superphosphate	11.56	$15 31
Superphosphate	13–16	$19 91 to 24 88
Superphosphate	16–18.5	28 71 to 33 91

Edward Packard & Co., of Ipswich, whose extensive works in the mining and the manufacture of phosphates have already been referred to, offer among many others:

	Sol. Phos. Acid.	Price per 2,000 pounds.
Superphosphate	17.54 per cent.	$32.08

Besides the above they offer those containing respectively 10, 12, 15, 16, 17, and 18 per cent. of soluble phosphoric acid.

An examination of the various fertilizers mentioned in the preceding price-lists representing the state of the trade over a very wide extent of territory, and in those sections where the business may be fairly considered as settled down to a sound basis, it will be seen that of the thirty-four superphosphates offered for sale by the several German manufacturers, the content of soluble phosphoric acid ranges from a maximum of 25 to a minimum of 10 per cent., *and in none falls below the latter number*, and the average content of the entire thirty-four is *fifteen and two-thirds* per cent.; while an examination of the twelve for sale by English manufacturers shows a maximum of 18½ and a minimum of 11 per cent., while the average of the twelve is *fourteen and nine-tenths* per cent. of soluble phosphoric acid.

35. Price per pound of soluble phosphoric acid.—The average cost per pound of soluble phosphoric acid in the 34 German superphosphates is about $10\frac{1}{12}$ cents; while the average price of the 12 English superphosphates is 8¾ cents. There is, however, considerable variation in the market value of this constituent, depending upon the raw phosphate from which the superphosphate is produced. This will readily appear by reference to the scale of prices given by Messrs. Cunningham, of Edinburgh, or Messrs. Owens, of Copenhagen. The former manufacturers sell, as will be seen, one pound of soluble phosphoric acid, from coprolites, at $8\frac{9}{10}$ cents; from bone-ash, at 9½ cents; from French phosphate, at $9\frac{6}{10}$ cents; from guano, at 11 cents. The latter firm sell one pound from South Carolina phosphate, at 9⅕ cents; from coprolites, at 9½ cents; from Mejillones Island guano, at 11⅜ cents; from Baker's Island guano, at 12¼ cents. It is doubtless due to the fact, that any small percentage of phosphoric acid which in the superphosphate still remains in the original natural condition, possesses a very marked difference in value, that the above variations in the price of the soluble exist; nevertheless it is worthy of note that, almost with-

out exception, no reference or allusion is made to any other form or modification of phosphoric acid, by any of the above manufacturers, than that which is the sole characteristic of a *superphosphate*, viz, phosphoric acid soluble in water.

By reference also to the ammoniated superphosphates given in the various price-lists, we find an average composition of the 21 to be as follows: nitrogen, $5\frac{7}{10}$ per cent.; soluble phosphoric acid, $10\frac{1}{2}$ per cent.; the amount of each of these constituents varying in the different fertilizers, from a maximum of 15 per cent. to a minimum of 4 per cent.

36. ANALYSES OF AMERICAN FERTILIZERS.—For sake of comparison it may be well to give the composition of some of our American superphosphates, made by different chemists from time to time, and of brands for sale in the several sections of the country.

In the report of the Connecticut Board of Agriculture for 1868, Prof. S. W. Johnson gives the analyses of 16 superphosphates and other commercial manures, sold in that State, and their content of phosphoric acid, (soluble and insoluble,) and of nitrogen is given, which results are here given:

Analyses by Professor Johnson.

Soluble phosphoric acid	0.00	0.00	3.19	7.91	12.88	3.93	0.00	0.00
Insoluble phosphoric acid	9.24	19.18	16.16	4.96	1.81	8.64	2.17	2.32
Nitrogen	6.46	1.38	2.00	2.31	3.97	2.90	.11	.10
Soluble phosphoric acid	0.00	0.00	0.00	30	1.42	.79	1.38	5.75
Insoluble phosphoric acid	0.00	2.48	9.48	15.95	9.26	8.16	13.16	10.38
Nitrogen	1.04	4.37	1.61	2.13	2.01	.52	2.70	1.68

In the Bulletin of the Bussey Institution for 1874, Prof. F. H. Storer gives the analyses of 11 samples of superphosphates sold in Boston, which were examined by himself, as follows:

Analyses by Professor Storer.

Soluble phosphoric acid	4.81	3.75	4.49	10.23	5.67	6.55	10.23	1.46	7.68	9.15	9.12
Insoluble phosphoric acid	7.86	7.60	10.49	1.82	10.26	5.96	3.57	8.69	4.18	4.77	1.93
Nitrogen	1.25	.69	2.02	1.92	2.71	2.19	1.40	1.67	.95	1.01	2.72

In a volume entitled "American Manures," published in 1872 by Dr. William H. Bruckner, are given the results of 15 samples of various fertilizers, analyzed by himself. These fertilizers were sold principally in the Philadelphia and Baltimore markets.

Analyses by Professor Bruckner.

Soluble phosphoric acid	5.59	3.52	5.21	4.47	3.36	3.81	3.35	6.46
Insoluble phosphoric acid	7.20	15.25	8.28	6.79	14.38	11.13	9.36	8.31
Nitrogen	.78	0.00	1.44	.89	1.34	2.36	1.22	1.92
Soluble phosphoric acid	2.68	4.59	9.78	1.99	8.32	0.00	0.00	....
Insoluble phosphoric acid	13.93	13.31	1.63	20.35	6.63	22.49	1.51	....
Nitrogen	1.12	.65	2.92	.85	2.34	.80	.97	....

In the annual reports for 1874 and 1875, submitted to the State Board of Agriculture of Massachusetts, by Prof. C. A. Goessmann, State inspector of fertilizers, the following analyses of 10 fertilizers are given:

Analyses by Professor Goessmann.

Soluble phosphoric acid	9.05	9.60	5.57	11.32	6.12	5.40	4.32	8.28	10.68	9.16
Insoluble phosphoric acid	2.73	1.72	7.49	7.03	5.80	5.67	4.06	9.05	2.47	2.03
Nitrogen	2.16	2.23	1.61	1.81	2.58	2.50	4.30	2.03	2.10	2.43

In the report of the State Board of Agriculture for Vermont for 1872, are given the analyses of all the fertilizers for sale in that State, 26 in number, the results of which are here given:

Analyses by Professor Collier.

Soluble phosphoric acid	.64	8.59	5.95	4.85	5,29	4.53	1.49	6.44	9.76
Insoluble phosphoric acid	6.54	.41	5.85	7.86	10.45	9.92	11.39	6.15	2.47
Nitrogen	2.12	2.37	2.44	2.41	1.75	2.68	1.79	2.48	2.38
Soluble phosphoric acid	7.85	6.19	7.23	12.96	19.46	18.68	.35	3.48	8.38
Insoluble phosphoric acid	10.36	9.03	3.29	8.02	8.43	8.09	4.52	10.26	12.12
Nitrogen	2.51	1.12	1.59	1.79	0.00	.85	1.23	1.53	1.41
Soluble phosphoric acid	.69	3.86	3.45	2.73	0.00	5.55	5.35	6.06	....
Insoluble phosphoric acid	12.24	6.55	4.70	20.75	1.65	8.70	8.04	6.12	....
Nitrogen	1.53	2.80	1.85	.57	.73	2.53	2.05	.62	....

The analyses of several other samples of fertilizers (6 in all) made during the spring of 1875, and published by the secretary of the Vermont Board of Agriculture, are given:

Analyses by Professor Collier.

Soluble phosphoric acid	11.65	.46	8.42	1.71	8.38	11.60
Insoluble phosphoric acid	2.95	.73	6.92	11.83	4.19	3.91
Nitrogen	1.62	.35	2.11	1.57	4.04	2 24

Below, the average results secured by the various chemists are arranged chronologically:

37. AVERAGE RESULTS OF FOREGOING ANALYSES.

Year.	Number.	Chemist.	Per cent. soluble P_2O_5	Per cent. insoluble P_2O_5	Per cent. nitrogen.
1868	16	Professor Johnson	2.35	8.33	2.21
1870-'72	15	Professor Bruckner	4.21	10.70	1.31
1871-'72	11	Professor Storer	6.65	6.10	1.68
1872	26	Professor Collier	6.14	7.85	1.73
1873	5	Professor Goessmann	7.57	4.66	2.67
1874	5	......do	8.33	4.95	2.08
1875	6	Professor Collier	7.04	5.09	1.99
	84	General average	5.42	7.66	1.83

It certainly needs but a glance at the above results to see how unfavorably the superphosphates of our markets compare with those of Great Britain and the Continent. The principal points to be ob-

served are, first, the exceeding irregularity of composition, as shown by the analyses of every one of the chemists; second, the very large proportion relatively (nearly 60 per cent. of the total amount) of the phosphoric acid which is in the insoluble condition; third, the low grade of nearly every specimen analyzed.

It is, however, a hopeful sign for the future, so far as this important manufacturing industry is concerned—an industry so vital to the interests of agriculture—to see that the above table gives evidence of improvement, not uniform, steady, nor by any means satisfactory, but, nevertheless, decided improvement.

By comparing the average of the 16 analyses made in 1868 by Professor Johnson, with the average of the 16 made in 1873, 1874, and 1875, by Professors Goessmann and Collier, it will be seen that there has been during the past six or seven years, as evidenced by these analyses, *an average increase of* 225 *per cent. in the amount of soluble phosphoric acid*, and at the same time improvement in this, that there has been *a diminution of over* 40 *per cent. in the amount of insoluble phosphoric acid*, while the amount of nitrogen remains about the same.

38. COMMERCIAL VALUATION OF AMERICAN FERTILIZERS.—In estimating the commercial value of any given fertilizer, obviously the basis of calculation is the market value of the several constituents of which the given fertilizer is composed, or of the raw materials from which it is compounded in its manufacture, but owing to the enormous demands which agriculture has made upon such raw material, and the equally enormous supply which commercial enterprise has supplied from what have been unknown sources, until recent search had found them out, the prices of these raw products have been fluctuating, and there has been among chemists only an approximate agreement as to what scale should be adopted.

One important point of difference among them in their estimations is the value to be placed upon what is known as "reduced," "reverted," or precipitated phosphoric acid, a constituent of considerable importance in most of our American superphosphates, in nearly all of them existing as it does to the extent of several per cent. The relative value of this constituent as available plant-food is as yet unsettled, some regarding it as little more valuable than the insoluble acid, while others claim it to have a crop-producing value hardly second to that of the soluble phosphoric acid.

In the report by Professor Johnson, already quoted, after a full discussion of the reason for fixing the prices of the several constituents at the amounts he mentions in his report, he proceeds to estimate separately the various fertilizers, and his average results for the 16, together with the market value or selling price, also averaged, accompany his estimate of commercial value. Professors Goessmann, Storer, and Bruckner's averaged estimates of value, and also averaged selling prices of the series of analyses made by them, are also given:

39. Ratio of Price to Value in American Fertilizers.

Number.	Chemist.	Averaged market price per ton.	Averaged commercial value per ton.	Ratio of price to value.
16	Professor Johnson	$59 47	$21 36	100 to 36
15	Professor Bruckner	50 07	17 60	100 to 35
11	Professor Storer	56 36	36 32	100 to 64
10	Professor Goessmann	....	....	100 to 67

Professor Goessmann does not enter into the detailed estimation of the several fertilizers, but states their selling price to be on the average one-half more than their commercial value, and the same proportion of cost to value was true, very nearly, in the analyses made by myself.

After a thorough discussion of the results of his analyses and of the importance of securing to the farmers a supply of reliable fertilizers at a reasonable price, Professor Goessmann remarks: "An impartial consideration of the preceding statements shows that the present condition of our trade in fertilizers exposes the farmer, in an unusual degree, to serious losses; for the peculiar nature of most of our compound commercial manures renders it impossible for him to recognize by a mere casual examination even their approximate commercial value. Nothing short of a careful investigation regarding their chemical composition and the physical condition of their principal constituents can secure a correct idea concerning that question. My inquiries, as previously stated, tend to support the impression quite generally entertained by all those who have of late taken pains to study the character of many of our fertilizers offered for sale, namely, that articles of considerable less value than represented by the dealers are by no means of rare occurrence. Samples of the same brand, even, are noticed to vary at times in value from $10 to $15 per ton. To decide upon the price of an article without any guarantee of a definite composition, with no particular responsibility for compensation, is, to say the least, a peculiar attitude on the part of any dealer, and would not be regarded as satisfactory in any other branch of business. In mentioning these facts here, I do not intend to charge an entire class of business men with intentional fraudulent practice; nothing, in fact, can be farther from my intention, for I feel quite sure that, in the majority of cases, the main cause of the variations in the value of our fertilizers can be proved to be due to the vague notion on the part of many of our manufacturers of commercial fertilizers regarding the extent of the differences which, at times, do exist in the chemical composition of the various crude materials and refuse matters used in the preparation of their so-called standard fertilizers."

In reference to this same matter I cannot do better than quote the

remarks of Professor Storer, who says: "It might seem at first sight that the experience of farmers as to the value of most American superphosphates must be similar to that of the chemists, and equally conclusive to the minds of farmers; but, for obvious reasons, this is not the case. Few, if any, superphosphates are wholly worthless. Most of them do produce a certain beneficial effect when applied to moderately good land. The only trouble is that the benefit obtained is incommensurate with the money paid out. The farmer, in order to come to a definite decision upon a point like this, would have to make careful comparative experiments, such as he seldom has time to attend to; and the common result seems to be that by repeated trials of various fertilizers, each as worthless as the others, he practically becomes habituated to the use of materials which he has no good reason to esteem.

"At all events, the continued sale, year after year, of enormous quantities of very poor materials, shows conclusively that there must be hosts of farmers who are still unconscious that their money could be spent to better purpose. It is by analysis alone that the disreputable character of the American superphosphates, and the enormous differences, in respect to price and worth, which exist between them and those ordinarily sold in Europe, can be made manifest with conclusiveness and precision; but it would be seldom worth while for any single farmer to go to the expense of having analyses made of the fertilizers in his market, and practically it does not seem to do much good to publish lists of analyses like the one presented herewith.

"It is said to be a matter of common experience that when a fertilizer has once been publicly commended in this country by a responsible chemist, its quality is apt to undergo a rapid depreciation. On the other hand, the vendors of manures which have been pronounced bad, take small pains to improve the quality of their goods, but protest that their processes of manufacture have been perfected, and that the material now sold is excellent.

"Moreover, in view of the multitude of analyses which have now been made by chemists, at great cost of skilled labor, it would seem as if the time had come for striking at the root of the matter; in short, for taking some definite action by which to amend the existing system of making and selling manures in this country.

"The subject is really one of very grave and serious importance, both from the scientific and political point of view. So far as the actual loss to the farmers in money is concerned, it may be accounted a light, or, at all events, a comparatively unimportant misfortune, that they should pay out unwisely some hundreds of thousands of dollars every year to the dealers in manures, but is a very serious matter that the farmers are by this very fact of injudicious purchase made to persist in their ignorance, and are prejudiced more and more strongly every year against those sources of knowledge which would not only protect them from this particular form of loss, but also must be the principal means of agricultural improvement. There can be no question but that the low

quality of the commercial fertilizers now commonly sold in our markets exerts a most pernicious influence upon the growth of all American schools of agriculture, and obstructs agricultural progress throughout the land. It is idle to expect farmers to lend a ready ear to the teachings of science so long as they continue to suffer in her name, as they do now every time they pay an undue price for a fertilizer said to have been prepared in accordance with chemical theory. The experience of the European schools of agriculture shows conclusively that there is no one thing which tends more strongly to excite an interest in the sciences bearing upon agriculture among the farmers of a district than the introduction into its markets of really good fertilizing materials.

"There would seem to be a simple method of overcoming the present difficulty, namely, by procuring importations from Europe of guaranteed fertilizers of good quality, and encouraging the sale of such fertilizers in small packages, as well as by the usual large quantities. If a powerful society were to engage in this work, it would probably be easy to force up the standard of American manufacturers to the proper degree, and to introduce the system of selling by warranty."

40. **Frauds in fertilizers.**—It must be apparent at a glance that there is, in the manufacture and sale of these fertilizers, room for much gigantic fraud, and indeed evidence is not wanting to show that in every country, not even excepting our own, men have been found unprincipled enough to avail themselves of these advantages. Chemical analysis alone can suffice to determine the composition and value of a fertilizer, and this involves considerable expense. Shortly after the introduction of commercial fertilizers in England, the most excessive frauds were practiced upon the farming community; and even so late as 1855, Professor Voelcker declared "that if ever there was a time when the agriculturist had need to exercise special caution in the purchase of artificial manures, that time is the present, for the practice of adulterating standard fertilizers, such as guanos, superphosphates, and so forth, has reached an alarming extent." And quite recently one of the foremost of agricultural chemists, Professor Stoeckhardt, of Saxony says: "There can be no doubt that American agriculture will arrive at satisfactory results like ourselves in obtaining reliable fertilizers by strictly adhering to the chemical control adopted, and by providing for chemistry what it needs for efficient work, both confidence and ample means." And Professor Bruckner, in closing his book upon "American Manures:" "The reader should now be fully convinced, from the facts stated and analyses given, of the absolute necessity of national and State legislation to protect the farmers and the public from the rapacity of the manufacturers of fertilizers. There are grain, flour, liquor, tobacco, leather, oil, drug, and other inspectors appointed to protect purchasers and *honest* manufacturers and dealers. Fertilizers are equal in importance to any of those commercial articles mentioned, while there are greater facilities for fraud. In England and other European countries, the prices of these fertilizers are fixed by the amount and

value of the fertilizing elements contained in them, and in those countries concentrated fertilizers are inspected by government officials; and as the result of the rigid inspection-laws of Germany, purchasers are protected."

The cause of the results indicated in the above, and so conclusively proved by comparison of the averages of our own and of English and German fertilizers as shown in the preceding tables, both in regard to their quality and price, is due to the fact that in these countries at the present time these manufactories have passed into the hands of intelligent capitalists, who are content with fair and legitimate profits, and for the interest of whom it is to maintain a respectable standard for their products. We are undoubtedly also passing through this early stage of English experience, referred to by Professor Voelcker, but much more rapidly, it is earnestly to be hoped; but at the present in many of our markets may be found so-called fertilizers, the sale of which, in the present state of our knowledge of agricultural chemistry, is certainly a reproach, and should be made a criminal offense.

41. PREVENTION OF FRAUDS.—The important practical question here arises, what can be done to protect the public from these and similar frauds? First and foremost is intelligence concerning the general principles of vegetable growth, and this secured, there must inevitably arise a demand for better fertilizers; but at present, so long as manufacturers find abundant sales for almost any refuse matter or raw material of uncertain and varying composition, we can hardly expect them to voluntarily abandon a remunerative business for one which promises no greater profits. Indeed, it is doubtful whether at the present time a genuine superphosphate, such as in every English and German market commands a ready sale, would, except with a very limited number of our people, meet with any favor. For many years our people have become so thoroughly familiar with the physical and physiological properties of our standard fertilizers that they have erroneously come to regard them as essential in anything which has fertilizing value; but with the diffusion of knowledge and increased intelligence this state of things is passing away, and there is no doubt but that when the demand arises the competition of our manufacturers will soon supply us with home-made products rivaling in quality and price those which at the present time must be sought for in foreign markets, for, as we have seen, there exists within our borders an ample supply of all the raw material necessary for such production, and if needs be we can successfully compete with Europe in any other markets of the world to supplement our home supplies.

The testimony of Professor Voelcker as to the history of fertilizers in England is almost identical with German experience, as given by Professor Johnson, who says: "The German farmers have had the same experience. It is just about twenty-five years since in Germany, as here, the trade in superphosphates, guano, and similar commercial fertilizers began. The same stupendous frauds by adulteration and dilution of

good things were practiced there as they have been and, we have great reason to fear, still are carried on here. But the *Experiment station* has perfectly cured and rooted out these evils in all the districts where it has been established and appreciated. The experiment station there is prepared to furnish the farmers, at small cost, with an analysis of any fertilizer he proposes to buy. The farmers avail themselves of this aid. They will buy no fertilizer without an exact statement of its composition, and they buy with the understanding that any deficiencies in the stipulated amount of fertilizing matter shall be made good or deducted from the payment. Under such circumstances manufacturers can sell nothing that is not substantially what it claims to be. A further result of this system is that low-grade fertilizers are little sought, and those makers who can supply the best article, of uniform quality and at the lowest rate, have the business. With larger sales the dealers prosper, while the consumers are satisfied with their purchases, and instead of trying to see how they can get along with small use of purchased fertilizers, they are studying how to use the greatest quantities to advantage. The fertilizer market in Saxony and Prussia, where the experiment station has the universal sanction and confidence of the farmers, is quite as settled and satisfactory as any branch of trade, and the farmers there buy superphosphates, guanos, potash-salts, &c., with as much security of fair dealing as we can feel in the purchase of sugar or nails."

It appears, therefore, that our experience is by no means exceptional, that indeed it has been the universal experience of other nations, and that it has been only through increased intelligence in the agricultural classes that this state of affairs ceased. The agricultural societies of Great Britain and the experiment stations of Germany, which began with the single establishment at Moeckern in 1852, and which have so demonstrated their practical value that during the past twenty years they have increased to seventy in number—these agencies have been instrumental in diffusing practical knowledge concerning the composition of soils, crops, and fertilizers, and thus enabling them to understand their wants and intelligently to provide for them.

Obviously, any other means of prevention of fraud are temporary and partial, but the plan generally pursued of purchasing only upon a guaranteed analysis, which exists at present in several of our States, is a step in advance. Another point to be observed is, to buy only the product of reputable and intelligent manufacturers; for it is not unfrequently the case that errors, arising from ignorance or carelessness in manufacture, are as disastrous to the buyer as though resulting from deliberate fraud. Finally, it is important that manufacturers be compelled, either through the force of legal enactment or pressure of public opinion, to place upon each package offered for sale an analysis representing the guaranteed composition of the product, in order that the purchaser may be enabled to select that particular constituent which he wishes to apply to his crops.

CHAPTER V.

NITROGENOUS FERTILIZERS.

Peruvian guano—amount consumed; Estimated present amount of Peruvian guano; Steamed bone-meal—composition and prices; Fish-scrap and fish-guano; Fish-scrap—production in New England; Prices and composition of fish-scrap and guano; Chili niter, or soda-saltpeter; Ammonia salts; Price of sulphate of ammonia; New process for recovering ammonia from gas; Slaughter-house refuse; Composition and prices of dried blood.

The principal sources whence this important constituent, nitrogen, is obtained are the Peruvian guanos, ammonia salts, Chili saltpeter, raw bones, fish-scrap, animal excrement, and refuse; this last including a multitude of products hitherto waste, but of late years utilized to a large extent in the manufacture of artificial manures.

All of the above substances were fully represented at the Vienna Exposition, in one form or another, and probably no department illustrated more forcibly the economy which characterizes the present age; but, as has been observed, they were each a separate study by themselves, of local interest generally, and to be referred to, if at all, individually.

42. Peruvian guano—amount consumed.—Pre-eminently, historically, commercially, and in its agricultural importance and value, first in the list of nitrogenous fertilizers is Peruvian guano. The enormous amount of this material, averaging for Great Britain alone, during the first thirty years since its introduction, an annual consumption of fully 168,000 tons, and to-day in constant demand in every agricultural district of Christendom, causes it deservedly to occupy a prominent place in any discussion of the subject of commercial manures.

It has been estimated that the quantity of guano shipped from the Chincha Islands alone amounts to from 12,000,000 to 15,000,000 tons; while the exportation from the Guanape Islands, which began in 1868, is estimated to have reached an aggregate annual shipment of over a half million tons. The United States, although not prominent as yet among the consumers of these products, imports annually from 30,000 to 35,000 tons, principally from these last-mentioned islands.

43. Estimated present amount of Peruvian Guano.—Of course this enormous consumption has awakened inquiry into the prospective duration of these supplies, and quite recently the Peruvian government has had a careful survey completed of its various guano deposits, the result of which survey has shown the existence of more or less extensive guano deposits on many other groups of islands besides those of

Chincha and Guanape, from the former of which during the past thirty years our supplies have chiefly come, and from the latter of which our present guanos are obtained to a great extent. Although, of course, any exact estimation is practically impossible, and even an approximate one extremely difficult of the aggregate amount of these numerous deposits, there is good reason to believe that the supply is by no means about to be exhausted, and that in the future, as in the past, these islands will continue to furnish abundant supplies of this valuable fertilizer.

44. VARIATION IN QUALITY OF PERUVIAN GUANO.—Recently, however, as has been already remarked, a feeling of distrust has arisen in our agricultural communities in reference to this guano for so many years held in highest esteem, and this distrust has not been quite unfounded, as chemical analysis has too often shown. Professor Shepherd, jr., announces the variation of Chincha Island guano for sale in Charleston, S. C., from the year 1869 to 1873, to be as follows: Nitrogen, from 14.43 to 9.14 per cent.; phosphoric acid, from 14.01 to 10.30 per cent.; sand, from 15.91 to .39 per cent.; moisture, from 27.18 to 11.03 per cent. While of Guanape guano the following variations were observed during the same period: Nitrogen, from 12.88 to 8.20 per cent.; phosphoric acid, from 17.62 to 10.77 per cent.; sand, from 3.75 to .75 per cent.; moisture, from 29.96 to 11.83 per cent.

The results of the analyses by Professor Voelcker of samples of Peruvian guano, taken from different depths in the several deposits found upon the islands Huanillos, Punta de Lobos, and Pabellon de Pica, show a marked variation in the amount of the several valuable constituents, and therefore in their agricultural and commercial value; so that we can readily account for the variation observed by Professor Shepherd, without supposing any intentional fraud to exist on the part of the dealers. The results obtained by Professor Voelcker are as follows:

	Pabellon de Pica.	Punta de Lobos.	Huanillos.
	Per cent.	*Per cent.*	*Per cent.*
Nitrogen	6.6–15.1	2.6–10.0	6.7–10.4
Soluble phosphoric acid	1.7– 3.5	.4– 3.2	1.4– 5.3
Insoluble phosphoric acid	11.7–15.3	10.9–15.3	12.9–16.6
Nitric acid	.0– 1.2	.3– 3.5	.4– 2.9

The above evidence of excessive variation in every one of the valuable constituents is sufficient to show how great the care necessary to be exercised by those who are desirous that the world-wide reputation which this valuable fertilizer has for years maintained should not suffer, since, as it must appear, it would be easy for successive cargoes taken from the same deposit to vary very greatly in value. Indeed, as has been already intimated, it is generally recognized that the quality of Peruvian guano, heretofore accepted almost as a standard by which to estimate the relative value of other fertilizers, has suffered great deterioration, often, doubtless, through lack of sufficient care and supervis-

ion, and often, too, as unfortunately there is too abundant evidence, through gross fraud on the part of certain unprincipled dealers, who have sought by adulteration and dilution to increase the amount of their profits.

These facts concerning Peruvian guano afford additional evidence, if, indeed, any is needed to establish a fact which no one of authority upon either continent questions, that chemical analysis is alone sufficient to determine the commercial value of a fertilizer—is, indeed, the only means of estimating its probable agricultural value.

45. STEAMED BONE-MEAL—COMPOSITION AND PRICES.—In nearly every market throughout Europe there is found for sale a class of fertilizers rich in nitrogen and phosphoric acid, which latter constituent exists in a condition intermediate between the soluble and insoluble form, but nevertheless in a state to be readily appropriated by the growing plant. These fertilizers, which meet with enormous sales year after year, have a well-established reputation and an agricultural value generally recognized, supplementing as they do the more active guano and superphosphates. Nearly every large manufacturer of superphosphates deals largely in this class of fertilizers, which are prepared by steaming finely-ground bones, and they may, therefore, be regarded as one of the standard fertilizers among European agriculturists.

The following analyses and prices, furnished by several leading manufacturers, will give an idea of the relative value of these: No. 1 is from H. & E. Albert, of Biebrich, in Hesse-Nassau; Nos. 2, 3, and 4 from Ludwig Michaelis, of Glogau, Silesia; No. 5 from the Berlin steamed bone-meal manufactory of Dr. William Cohn, at Martiniquefeld; No. 6 from the Oranienburg manufactory near Berlin; Nos. 7 and 8 from the Heufeld manufactory in Upper Bavaria; No. 9 from Messrs. Dorrman & Hottendorf, of Ottendorf, Hanover.

No.	Manufacturers.	Percentage of phosphoric acid.	Percentage of nitrogen.	Price per ton of 2,000 pounds.
1	H. & E. Albert, Nassau	22	2½–3	$40 90
2	Ludwig Michaelis, Silesia	24	4	45 45
3	......do	7	11	59 09
4	......do	15	8	53 45
5	William Cohn, Prussia	22–24	4–5	44 36
6	Oranienburg, Prussia	20–22	3–4	42 00
7	Heufeld, Bavaria	22	3½	42 91
8	.....do	20	3	41 27
9	Ottendorf Company, Hanover	20	4	42 27

The average composition of the above nine fertilizers is phosphoric acid 19¾ per cent., nitrogen 5 per cent., and the average price is $45.75, which would give an approximate value to the nitrogen of 22½ cents per pound, and to the phosphoric acid of 6 cents per pound.

Another highly nitrogenous substance of pretty general use as a fertilizer is the gelatinous matter obtained as a refuse product from bones.

This bone-gelatine, as it is termed, is quoted at the Heufeld manufactory as follows, by the ton:

No. 1. Nitrogen 9 per cent., phosphoric acid 3 per cent., at $42.91.

No. 2. Nitrogen 6 per cent., phosphoric acid 2 per cent., at $31.21.

46. FISH-SCRAP AND FISH-GUANO.—Still another abundant source of nitrogenous material, and one which for many years, in one form or another, has been utilized for this purpose in nearly every country, is found in fish. In our own country especially this material is in very extensive use throughout the sea-coast of New England, where immense quantities of fish are taken for the oil they contain. This being extracted, the "scrap," "pomace," or "chum," as it is termed, is devoted to agriculture. Latterly the various parties engaged in this industry have organized themselves into a company entitled "The United States Menhaden Oil and Guano Association."

47. PRODUCTION IN NEW ENGLAND OF FISH-SCRAP.—From the published statistics of production, it appears that the annual yield of fish-scrap during the past few years has amounted to the following: In 1871, fish-scrap, 44,500 tons; in 1872, fish-scrap, 32,570 tons; in 1873, fish-scrap, 36,299 tons; in 1874, fish-scrap, 50,976 tons. The amount of fish taken in 1873 amounted to 1,193,100 barrels, yielding 2,214,800 gallons of oil, and in 1874 to 1,478,634 barrels, yielding 3,372,837 gallons of oil. The amount of capital invested in this industry amounts to $2,500,000, giving employment to about 2,500 men.

48. PRICES AND COMPOSITION OF FISH-SCRAP AND FISH-GUANO.—Analyses of this fish-scrap show it to be an abundant source of nitrogen, but, owing to the enormous quantity of this material accumulating during the busy season, and the tendency to rapid decomposition, there is very great danger of loss of nitrogen; and the various samples in our markets are found to differ very widely in composition and value. The following analyses will illustrate this point. Nos. 1 and 2 are taken from the bulletin of the Bussey Institution; No. 3, from Professor Goessman's report:

No. 1. Fish-scrap, 5.50 per cent. nitrogen, 7.28 per cent. phosphoric acid.
No. 2. Fish-scrap, 6.42 per cent. nitrogen, 5.59 per cent. phosphoric acid.
No. 3. Fish-scrap, 5.06 per cent. nitrogen, 4.68 per cent. phosphoric acid.

The above material is used very extensively in the manufacture of superphosphates as a convenient means for supplying a nitrogenous constituent, and the price averages about $15 to $20 per ton, though subject to considerable fluctuations from causes already noticed, at times falling as low as $9 per ton.

By partially drying and pulverizing the "scrap" a fertilizer is prepared known in the trade as "fish-guano," the price for which is about $40 or $50 per ton.

The following analyses of this fertilizer, made by Professor Goessmann, show even greater variations in the different samples than are found true of the raw material itself:

No. 1. Fish-guano, 6.17 per cent. nitrogen, 7.20 per cent. phosphoric acid.
No. 2. Fish-guano, 7.31 per cent. nitrogen, 7.10 per cent. phosphoric acid.
No. 3. Fish-guano, 3.63 per cent. nitrogen, 13.67 per cent. phosphoric acid.
No. 4. Fish-guano, 6.43 per cent. nitrogen, 13.89 per cent. phosphoric acid.
No. 5. Fish-guano, 8.38 per cent. nitrogen, 7.85 per cent. phosphoric acid.
No. 6. Fish-guano, 5.72 per cent. nitrogen, 4.58 per cent. phosphoric acid.

Along the shores of the Baltic and North Seas, in Denmark, Norway, and Sweden, large quantities of this raw material are utilized in the preparation of so-called fish-guanos, many specimens of which from these countries were exhibited, many of them being of excellent mechanical condition and high percentage composition of nitrogen and phosphoric acid. Messrs. Dorrman and Hottendorf, of Ottendorf on the Elbe, in Hanover, give in their price-list of fertilizers a fish-guano, made from fish caught on the shores of the North Sea, of the following composition and price per 2,000 pounds: Nitrogen, 13 per cent.; phosphoric acid, 8 per cent.; $54 to $59—a price much higher than our similar products bring in our markets.

At Barcola, near Trieste, a very excellent guano is prepared by roasting the scrap in large iron kettles until a rich brown color is obtained.

49. CHILI NITER OR SODA SALTPETER.—During the past twenty years the extraction and transportation of sodium nitrate from the vast deposits of this material, found in the district of Tarapaca, in the department of Moquegua, in Southern Peru, has developed into a great industry, and the quantity annually supplied from this country to agriculture and the arts—for it is also used as a source of nitric acid and for conversion into potassium nitrate by treatment with the potassium chloride of the Stassfurt mines—exceeds 500,000 tons. Recently the Peruvian government has restricted the manufacture to 4,500,000 tons annually, which maximum yield will doubtless soon be secured, owing to the rapid increase of those engaged in its extraction. About fifty manufactories are already in operation or in process of construction, and when completed it is estimated that their productive capacity will approach 6,000,000 tons annually. Commercial Chili niter contains a variable quantity, generally from 90 to 95 per cent., of sodium nitrate, equal to 14.82 to 15.65 per cent. of nitrogen. The price varies both in this country and upon the continent from $65 to $75 per ton. The price of nitrogen present in this material would average, therefore, from a minimum of 20$\frac{8}{10}$ cents to a maximum of 25$\frac{3}{10}$ cents per pound.

50. AMMONIA SALTS.—In the destructive distillation of bituminous coal, in the well-known process of manufacturing illuminating gas, or of any other nitrogenous material, a variable proportion of nitrogen escapes in the form of ammonia. In the case of coal, containing as it does from 1 to 1½ per cent. of nitrogen, the total amount of ammonia thus produced in the gas-works of our larger cities equals many thousands of tons; and our commercial supplies of ammonia and ammonia salts are chiefly derived from this source by well-known processes.

The most abundant product thus obtained is the ammonia sulphate, which is principally devoted to agriculture, since it contains in its crude state from 20 to 21 per cent. of nitrogen. It is subject to great fluctuations in price, but the following quotations from several dealers will give an approximate idea of its valuation:

51. PRICE OF SULPHATE OF AMMONIA.—William Cohn, Berlin, Prussia, $101 per ton; H. & E. Albert, Biebrich, Nassau, $117 per ton; J. & J. Cunningham, Edinburg, $106 per ton. In the United States the price varies from $90 to $120 per ton.

52. NEW PROCESS FOR RECOVERING AMMONIA FROM GAS.—Recently certain manufacturers of superphosphates in England have employed this substance in place of the lime and iron-oxide, in the gas-purifiers in use by the manufacturers of illuminating-gas, and by passing the gas as taken from the retorts, over this acid salt, the ammonia unites with the superphosphate, and it is found upon examination of the gas to be completely removed, while in combination with the superphosphate it constitutes a most valuable fertilizer. By this process not only is the illuminating-gas freed from ammonia, but this valuable product is secured at small expense, and in a condition immediately available to the agriculturist at a greatly reduced price. This process is a modification of the method used some years since by which other acid salts, or even sawdust moistened with sulphuric acid, were employed to fix the ammonia; and there appears no good reason why in the future this waste product in the gas-works of most of our smaller cities should not be saved to our lands, especially since the increased demand of agriculture for this fertilizer has forced the price far above its usual rates.

Obviously the same material may be employed for fixing ammonia from any other source, as in the preparation of bone-black.

53. SLAUGHTER-HOUSE REFUSE.—During the past few years the increasing demand for nitrogenous fertilizers has led to the utilization of the refuse of slaughter-houses, and generally the result has been the preparation of a class of manures very rich in nitrogen, and containing variable though usually small quantities of phosphoric acid.

Commercial manures from these refuse-matters were among the most interesting of the exhibits in this group. The composition and prices of representatives of this class of fertilizers are given below:

Name.	Manufacturers.	Percentage of nitrogen.	Price per ton of 2,000 pounds.
Dried blood	J. & J. Cunningham, Edinburgh	11.5	$58 00
Blood powder	Union Manure Company, Magdeburg	12	57 00

This material has also been made use of in our own country quite extensively in the larger cities of the Union, and the products compare

very favorably both in composition and price with those in Europe. The increased amount of phosphoric acid which fertilizers of this class contain in our country is due to the presence of more or less bone-refuse, which, in the process of manufacture, is included with the blood and meat scraps. A few analyses of manures of this class, with prices, are given below:

54. COMPOSITION AND PRICES OF DRIED BLOOD, ETC.

Number.	Name.	Where made.	Percentage of nitrogen.	Percentage of phosphoric acid.	Price per ton of 2,000 pounds.
1	Blood, bone, and meat dust	Boston	4.89	12.08	$40 00
2	Blood flour	New York	11.22	.80	70 00
3	Animal dust	Boston	6.24	12.01	50 00
4	......do	....do	7.14	8.76	50 00
5	......do	....do	4.86	13.05	47 00
6	Azotin	New York	7.41	....	50 00

From the above analyses it will be seen that we have in this refuse the material for a class of fertilizers comparing favorably with our best nitrogenous manures, and leaving nothing to be desired other than a regularity of composition such as is maintained in these and other commercial manures abroad, since it is only by such means that confidence in these valuable products can be established and retained. The need of greater care in the manufacture of these will appear from consideration of the analyses of the so-called animal dust, the three samples of which are seen to differ very widely in their composition. That, however, this obvious objection is simply an attendant of preliminary efforts in the manufacture of this fertilizer, and will soon be remedied, we have ample assurance.

Analyses 1 and 2 are from the Bulletin of the Bussey Institution; 3, 4, and 5 are from the report of Professor Goessmann, to both of which publications reference has already been made.

CHAPTER VI.

POTASSIUM FERTILIZERS.

POTASH FROM WOOD-ASHES; ANNUAL PRODUCTS OF THE STASSFURT DEPOSITS; GEOLOGICAL CHARACTER OF THE STASSFURT BEDS; IMPORTANCE OF POTASH AS A FERTILIZER; COMPOSITION AND PRICES OF POTASH SALTS AT STASSFURT; COST PER POUND OF POTASH IN VARIOUS SALTS; COMPOSITION AND PRICES OF STASSFURT SALTS IN THE UNITED STATES.

The most abundant source of potassium salts is the remarkable deposits in the beds of Stassfurt, in Saxony. The exhibits from this and the neighboring locality of Leopoldshall were very complete and satisfactory, illustrating the various minerals occurring in these mines, as also the series of chemical products resulting from their manufacture. This deposit was first developed in 1861, and the aggregate production of potash salts amounted that year to about 2,400 tons; but this production rapidly increased, as may be seen in the following table, which represents the aggregate products of the various mines at Stassfurt and Leopoldshall. The number of factories engaged in the manufacture of these crude salts into commercial products has increased threefold, while the amount of products has increased from 20,400 tons in 1862, to 514,200 tons in 1872.

55. POTASH FROM WOOD-ASHES.—The commercial revolution in the potash industry, occasioned by the opening up of this enormous supply, may be easily imagined, when we consider the extent of our supplies of commercial potash before the discovery of these deposits in Stassfurt. Our principal sources hitherto have been the product from wood-ashes, estimated by Professor J. Lawrence Smith to have been approximately 30,000 tons annually, of which gross amount the several countries furnished about as follows: United States and British America, 13,000 tons; Russia, 9,500 tons; France, 2,500 tons. But of late years the destruction of our forests, and the general introduction of coal as fuel, has greatly diminished our supplies of potash from this source, while the increasing demands of the arts had practically monopolized the entire supply of this indispensable constituent of fertilizers.

56. ANNUAL PRODUCTS OF THE STASSFURT AND LEOPOLDSHALL POTASH MANUFACTORIES.

Year.	Number of factories.	Tons of product.	Year.	Number of factories.	Tons of product.
1861	....	2, 400	1867	16	167, 500
1862	....	20, 400	1868	18	201, 700
1863	11	64, 400	1869	20	230, 000
1864	19	138, 800	1870	21	312, 200
1865	16	95, 000	1871	25	403, 200
1866	16	172, 600	1872	33	514, 200

At the present time this potash industry employs exclusively, not including those engaged in salt-mining proper, about 1,100 miners and some 3,000 other workmen; and the villages of Stassfurt and Leopoldshall have increased in their population from 2,700 to more than 12,000 during the past ten years.

The principal products of these mines, besides common salt, are the chlorides and sulphates of potassium and magnesium. This industry has, during the few years past, effected a great reduction in the price of several important chemical products, especially in saltpeter, which is prepared in large quantities by treating sodium nitrate from Chili niter with the potassium chloride produced from the mines; and in bromine also, which in 1865 was worth from 16 to 17 thaler per kilogram, *i. e.*, from $5.50 to $5.80 per pound, is now worth only from $1 to $1.20 per pound. Potassium chloride also, which, but a few years since brought from 4¾ cents to 5½ cents per pound, is now sold at about 2 cents per pound.

Of the entire production of these mines, about 70 per cent. is exported to England, France, Belgium, and the United States, and used in these countries almost exclusively for fertilizing purposes.

57. GEOLOGICAL CHARACTER OF THE STASSFURT DEPOSITS.—This saline deposit at Stassfurt consists of a bed of nearly pure rock-salt 215 meters in thickness, interlaced by thin seams of anhydrite, (anhydrous sulphate of lime,) above which lies a bed of impure rock-salt about 63 meters in thickness. Above the bed of impure rock-salt lies a third bed of about 56 meters thickness, in which, besides rock-salt, the sulphates abound, and lastly follows the fourth bed, which is the one containing the potash salts. This bed is about 42 meters in thickness, and is made up of potash and magnesia salts, mixed up with variable quantities of common salt. The entire saline deposit is covered over with a layer of bunter sandstone about 250 meters in thickness. This remarkable deposit was first opened up in 1861, and in 1872 the yield was over 1,000,000 centners of common salt, and nearly 4,000,000 centners of potash salts. The mines at Leopoldshall, upon the same deposit probably as those at Stassfurt, were opened in 1869, and in 1872 yielded a gross product of potash salts and common salt of 6,000,000 centners.

58. IMPORTANCE OF POTASH AS A FERTILIZER.—When we consider that about 30 per cent. of the entire mineral matter taken by our cereal crops consists of this compound potash, and that upon many "exhausted" fields such marvellous results have often followed the application of wood-ashes or some other fertilizer rich in potash, the agricultural value of this discovery of the Stassfurt deposits can scarcely be overestimated. Indeed, it would seem that the thoughts of the agriculturists and of the manufacturers of commercial manures had been almost exclusively pre-occupied with considerations concerning their supplies of phosphatic and nitrogenous fertilizers, to the comparative neglect of another and equally pressing want. For one purpose and

another, the arts have almost entirely absorbed our home-supplies of potash, and it was only by competing in the market with the prices which a steadily increasing demand maintained that until now the farmer has been able to restore to his soil this important constituent of every crop. Since public attention has been directed to these new supplies the demand for them has steadily increased in the United States and there can be no doubt but that, so soon as the expenses of importation shall have been reduced to a minimum, the demand for and use of these invaluable fertilizers will very rapidly increase in our country.

The following quotations from the price-list of the Stassfurt Chemical Manufacturing Company at Stassfurt will give the price per ton of 2,000 pounds of these several potash salts at the mines:

59. COMPOSITION AND PRICES OF POTASH SALTS AT STASSFURT:

(1.) Potash fertilizer, containing from 16 to 22 per cent. sulphate of potash = 9 to 11 per cent. potash, $6.90.

(2.) Concentrated potash fertilizer, containing 25 per cent. potash, $23.82.

(3.) Triple concentrated potash fertilizer, containing 55 to 59 per cent. sulphate = 30 to 32 per cent. potash, $29.64.

(4.) Potash-magnesia sulphate, containing 28 to 30 per cent. sulphate of potash = 15 to 18 per cent. potash, $11.50.

(5.) Refined sulphate of potash, containing 78 to 80 per cent. sulphate of potash = 43 to 44 per cent. potash, $63.64.

(6.) Potassium chloride, containing 80 to 85 per cent. potassium chloride = 50 to 53 per cent. potash, $47.82.

(7.) Purified potash-magnesia sulphate, containing 52 to 56 per cent. potash sulphate, and 30 to 38 per cent. magnesia sulphate = 28 to 30 per cent. potash, $51.27.

(8.) Sulphate of magnesia, containing 60 per cent., $6.90.

60. COST PER POUND OF POTASH.—The cost per pound of potash, (oxide of potassium,) in the several fertilizers in the above price-list, is as follows: No. 1, $3\frac{5}{6}$ cents per pound; No. 2, $4\frac{3}{4}$ cents per pound; No. 3, 5 cents per pound; No. 4, $3\frac{5}{6}$ cents per pound; No. 5, $7\frac{2}{3}$ cents per pound; No. 6, $4\frac{4}{5}$ cents per pound. It will be observed that the cost per pound of potash increases gradually with the degree of concentration of the compound, and its purity; and that the price of potash in the form of chloride is two-thirds that in the form of sulphate.

61. COMPOSITION AND PRICES OF STASSFURT SALTS IN UNITED STATES.—Within the past few years these fertilizers have been introduced into our markets and are offered at the following prices in currency, per ton of 2,000 pounds:

(1.) Kainite, containing 23 to 25 per cent. sulphate of potash = 12.44 per cent. potash, $30.

(2.) Sulphate of potash, containing 40 to 44 per cent. sulphate of potash = 21.63 per cent. potash, $50.

(3.) Chloride of potassium, containing 80 per cent. potassium chloride = 50.54 per cent. potash, $60.

(4.) Leopoldshall kainite, containing 24 per cent. sulphate of potash = 13 per cent. potash, $24.

The 1, 2, 3 of the above are offered for sale in Boston; the 4, in New York; and the cost per pound of potash in the above is as follows: No. 1 as sulphate, $12\frac{1}{4}$ cents per pound; No. 2 as sulphate, $11\frac{3}{5}$ cents per pound; No. 3 as chloride, 6 cents per pound; No. 4 as sulphate, $9\frac{2}{9}$ cents per pound.

The difference in price between the sulphate and chloride is more marked than in the former price-list; and although the prices are far in advance of those previously quoted, there is no doubt but that future importations and the inevitable results of competition will considerably reduce the price of these valuable fertilizers.

It is to be presumed that the importers of these salts buy and sell upon guaranteed analyses, and the importance of this to all parties is obvious in view of the fact that the circular and price-current of No. 4 publishes analyses of the product differing very widely from each other as follows: 24.06 per cent., 27.86 per cent., 29.02 per cent., and 32.06 per cent. of sulphate of potash; differences so great as to prove the product for sale to be of very uncertain composition, and demanding on the part of buyer and seller alike constant care to prevent injustice and loss.

CHAPTER VII.

CHEMICAL PRODUCTS FROM HOUSE-REFUSE AND SEWAGE.

STANFORD'S PATENT CARBON SYSTEM; ADVANTAGE OF THE USE OF CARBON; CHEMICAL PRODUCTS OBTAINED FROM EXCRETA; AMOUNT OF PRESENT WASTE IN SEWAGE; UTILIZATION OF SEWAGE BY IRRIGATION IMPRACTICABLE; SANITARY CONSIDERATIONS RELATING TO PRESENT SYSTEM.

One of the most interesting and practically valuable exhibits was a series of chemical products from sea-weed, obtained by means of the process of Edward C. C. Stanford, F. C. S., and exhibited by the British Sea-Weed Company, for which process medals have been awarded at the various exhibitions held since 1862. This improved process consists in subjecting the sea-weed to destructive distillation in iron retorts instead of burning it into a crude product, generally known as kelp. In making kelp, owing to the high temperature employed, much of the iodine is dissipated, in many cases a large percentage of this valuable constituent being lost. The product, moreover, is a crude slag difficult of lixiviation, and after lixiviation the residue is valueless. By destructive distillation the sea-weed is converted into charcoal, which remains in the retorts, and ammoniacal liquor and tar, condensed in suitable condensers, and gas, which is used for purposes of illumination in the works. The gas-liquor yields ammonia and acetic acid; from the charcoal the salts of potassium and sodium, with the metallic iodides and bromides, are easily removed by washing, and a residual charcoal is obtained, which resembles that prepared from bones. This charcoal is a most powerful deodorizer and decolorizer, and can be produced at one-fourth the price of animal charcoal.

The sea-weed exhibited is collected in the winter on shores in the Hebrides, where hitherto it has not been secured, thus giving employment to a large number of the poorer classes when they most need it. The potassium salts exhibited were all obtained from the chloride and sulphate, the first crude salts extracted from the charcoal. The caustic soda was obtained from the crude soda salts.

62. STANFORD'S PATENT CARBON SYSTEM.—The above interesting series was supplemented by a series far more interesting, representing the chemical products from house-refuse and sewage, obtained by Stanford's patent carbon system, and exhibited by the inventor of this admirable system. The general method employed is but a modification of the above, the residual carbon obtained by that process being employed as an absorbent and deodorizer in the so-called earth-closet in

place of dry earth; and by this arrangement the problem which has so long perplexed municipal authorities and the general government—the economical utilization of the valuable constituents of sewage—seems practically solved.

The investigations and discoveries of Mr. Stanford have resulted in furnishing a perpetual deodorant out of the impurities of animal life. The sanitary result of the process is perfect, and the whole value of the excreta dealt with is fixed from the moment of the application of the deodorant, its noxious and offensive character being removed promptly and effectually, while the intrinsic value is retained. This process is already in extensive use in many parts of England and Scotland, and has in every case given unqualified satisfaction.

The system of the Carbon Fertilizer Company, in present operation, consists in furnishing to those desiring to avail themselves of the privileges of the company a sufficient supply of charcoal, in removing the mixed product, both supply and removal being free of cost to the consumer. The application is similar to that of earth in the earth-closet, and with but slight modifications the system is universally applicable for the saving and utilization of either solid or liquid excreta in the house, workshop, factory, hotel, or on shipboard.

63. ADVANTAGE OF THE USE OF CARBON.—The chief advantage which this employment of charcoal possesses over earth consists in this, that not more than one-fourth of the quantity of charcoal is required as of dry earth; and by the process the original amount of charcoal employed is continually increased.

64. CHEMICAL PRODUCTS OBTAINED FROM EXCRETA.—To follow this system in detail, sea-weed, peat, or other charcoal is used; the excreta mixed with this material are removed and distilled in iron retorts, the products being ammoniacal liquor, tar, and gas; from this liquor sulphate of ammonia and acetate of lime are obtained. The charcoal remains in the retort, and can be used again any number of times for recharging the closets. At every redistillation it increases by the addition of the carbon derived from the excreta. This carbon contains all the potash and the phosphates of the excreta, and is worth in the English markets £5 per ton. When mixed with the ammonia sulphate obtained in the distillation it forms the nitro-carbon manure, so called, and is worth about £10 per ton. This company is prepared to treat with any individuals, corporations, or towns. In dealing with corporations they grant an interest in their profits after payment of 10 per cent. per annum to their stockholders. In treating with large employers of labor they pay an annual interest upon the capital invested in introducing their system, besides furnishing fresh charcoal and removing excreta free of all expense.

65. AMOUNT OF PRESENT WASTE IN SEWAGE.—The importance of this matter is such that it should have further consideration, since while in its sanitary relations it is already receiving the most careful attention

in all of our larger cities, its economical relations are none the less important, and from that point of view alone it has been for a long time considered by our most intelligent agriculturists.

The removal of crops from our fields, and their transportation, is constantly impoverishing our lands, and it is only in rare instances that any compensating return is made. A moment's reflection will convince us that for the most part the refuse products of all this consumption find their way by ten thousand channels, more or less direct, to that common reservoir, the sea; but few of us, I presume, are aware of the startling proportions which this waste assumes; and that we may all unite in the increasing protest against its continuance, a few statistics will be presented. Professor Way and Mr. Lawes, of England, estimate the value of the excreta of a city of 500,000 inhabitants at over a million dollars annually, and in amount equal to 385 tons daily. It has been estimated that the annual waste of fertilizing material in the various cities of the United States would half pay the interest upon our national debt. Incredible as it may at first appear, a few statistics will make it far less surprising.

In the city of London forty wagons are constantly busy in carting away the refuse from street-sweepings, and in one year 55,000 wagon-loads were thus removed. In the city of Paris this fertilizing material is farmed out to a company for about $600,000 annually. According to the director general of the Bavarian experimental station, there is an annual loss, in the city of Munich alone, of the one constituent, nitrogen, amounting to half a million of dollars, and representing an amount of this valuable fertilizer equal to about 1,000 tons, and this in a city of only 177,000 inhabitants; and yet alongside of this enormous waste stands the fact that for this same constituent, nitrogen, as present in guano, fish-pomace, and similar fertilizers, the German farmers are expending annually about $3,000,000. Antwerp, formerly paying $5,000 a year to get rid of her street-refuse, now receives an annual income of $200,000 for the same. It has been estimated that in nearly every city of 100,000 inhabitants there is an annual waste of full 60 tons of phosphoric acid, worth about $20,000 to the agriculturist.

In view of this enormous waste, to supply which the islands of the sea have been ransacked for guano now rapidly becoming exhausted, the whitened bones of ancient battle-fields have been gathered up, and the tombs of a former race despoiled, Professor Liebig long since declared that the "coming generation will consider those men as the greatest benefactors of mankind who devote all their efforts to save and utilize the fertilizing material of the cities." In view of such testimony and from such a witness it is certainly worth our while to examine into the claims set forth in this system devised by Mr. Stanford, and if possible with economy, to prevent this tremendous waste in our larger cities, and thus restore to our fields, already impoverished or rapidly becoming so, the material for new and increasing crops.

But important as are the considerations of this question from an economic stand-point, there is another view of the matter vastly more important—its relations to the sanitary condition of our people; and so important has the question become from this point of view alone that any system which shall serve to rid our larger cities of this omnipresent and increasing nuisance will be most heartily welcome, even though, instead of being made a source of revenue, it shall be accomplished at a great expense.

The efficacy of water-sewage has not only long been questioned, but indeed in many cases has been found quite unsatisfactory, not only from the enormous waste involved, but also from the added expense of the water-supply necessary to render this system available, since it requires at least 350 times the weight of the entire excreta, liquid and solid, and some 4,000 times the amount of solid excreta to be removed. But not alone does this system, almost universal as it is, involve this great waste and expense, but it entails the most serious consequences. The sewage of London has already accumulated an amount of matter so great as to seriously threaten the navigation of the Thames, it having been shown that in certain places the main channel had diminished from 21 to 10 feet; and according to an article published in the Pall Mall Gazette, entitled "The Sanitary Dead-Lock:"

"It has now been decided that although Parliament has conferred the right of drainage into the sea and public rivers, this right can only be exercised subject to the condition that no other nuisance is thereby created. 'The notion of collecting all the sewage of a large town, says Vice-Chancellor Wood, in the case of Blackburn, 'and pouring it into a river without the slightest attempt to clear it of any of its grossest impurities, is simply monstrous.' And again, in the Attorney-General *vs.* Birmingham Town Council, the court went so far as to declare that it would not balance the convenience of a town against the legal rights of an individual complainant; the latter must be respected. * * * Whatever may be the legal aspect of the question, it is quite evident that the navigation of the Thames cannot be allowed to be obstructed even for the sake of draining the metropolis, and that legislative interference will be required if the existing acts are at all doubtful on this point. Indeed, the whole subject demands the careful consideration of Parliament, in order to release the municipal authorities throughout England from the embarrassing position in which they are now placed. Some way must be discovered of draining our towns at a less sacrifice than is involved in the pollution of streams and blocking up of navigable rivers."

Mr. Stanford, in a paper read before the Glasgow Sewage Association, from which I quote, says: "The whole system of sewage by water-carriage is recklessly extravagant; it carries the solid and liquid excreta down to our neighbors, to rot at their doors, and it leaves us a legacy of deadly gases to remind us that our endeavor to cheat nature

has signally failed. As applied to even ridding ourselves of the nuisance, it is the finest effort of 'the circumlocution office,' and the best illustration of 'how not to do it' in our generation."

Engineers have employed an elephant to do the work of a mouse, and the burly brute has trodden down and has laid waste the country. Then, as to its utilization: here the system almost entirely breaks down. Notwithstanding numerous attempts, no portable manure ever has been, or ever will be, made out of sewage. The chemical value of average sewage, if it could be extracted, is a penny per ton, as deduced from ninety-three analyses of Rugby sewage, by Professor Way.

66. UTILIZATION OF SEWAGE BY IRRIGATION IMPRACTICABLE.—Nor, indeed, except in rare and isolated cases, can irrigation be employed as a method for utilizing this waste, owing to the immense extent of surface which would suffice to render this system available, since it is estimated that for a city of a half million inhabitants it would require from 12,000 to 15,000 acres of land.

In view, therefore, of all the objections urged against the system of water-sewage, its enormous waste of valuable material; its expense in fixtures and for water-supply; its interference with navigation on rivers; and, finally, its disastrous results, as manifest in the health-rates, the Sewage Association of Glasgow, to which reference has already been made, with all varieties of opinion as to what should be done, passed one resolution unanimously, viz, that, whatever system may be adopted, the excreta must be kept out of the public sewers.

In submitting his process to the Glasgow Sewage Association, Mr. Stanford presented the following details and statistics, from which it will readily appear that there exists not only a better way than that in common use in our cities, so far as regards health, but also that a wise economy will not long permit this source of revenue to remain neglected.

"The objections urged against the system, when earth is used, are," he says, "first, the large quantity of earth required—three and a half times the weight of the excreta; and, second, the difficulty of obtaining the quantity required, and of drying it. Now, both these difficulties are disposed of by using charcoal. I employ, by preference, sea-weed charcoal, because it is the most porous, the best absorbent, and the cheapest. It only requires one-fourth the weight, compared to earth; and, when the mixture is removed and placed under cover, it soon dries. This mixture can be stored for any length of time, and used again several times. When convenient, it is reburned, like the char in sugar-refineries, except that this process is carried out in apparatus which admits of collecting the ammonia and other products condensed. The whole of the ammonia is thus collected, while the phosphoric acid, potash, and mineral matters accumulate in the charcoal, together with the carbon from the organic constituents of the excreta. The weight of the charcoal is increased to the extent of about 5 per cent. with each using, and, if dried and reused five times, about 25 per cent. with each

reburning. With this constant addition, the char does not require replacing with fresh material, so that its cost is only a primary outlay; the ultimate result being that the excreta are deodorized by a charcoal derived from themselves, and a company working this process would, in addition to securing the whole of the ammonia, become sellers of a charcoal second only in value to that from bones to the extent of, in Glasgow, if the process were general, 19 tons a day, or 6,935 tons a year; the total quantity of excreta which Glasgow has to remove being 385 tons a day, and their value, at 29*s.* 6*d.* a ton=£569. The ultimate results being the same, any charcoal may be used at first. The process is carried on without odor, from the closets to the finished products."

In the several papers presented by Mr. Stanford to the Glasgow Philosophical Society, and from which I have freely quoted, the author gives the minutest details as to the analytical results of his process, with estimates of expenses and values of the various products, all which seem conclusively to prove that this process leaves nothing to be desired. Already, in our own country, the principal feature of the system, the dry-closet, has been widely adopted, and has never failed to give entire satisfaction. Testimonials from multitudes are at hand to prove it to be all that was ever claimed for it. The substitution of charcoal for earth has enabled the system to be economically introduced into our larger cities, thus enabling us, as for example in New York, not only to effect a saving in the enormous expense of a water-supply necessary to carry off this waste, (an amount of water at least *three hundred and sixty-four* times the entire weight of the excreta to be removed, and about *four thousand times* the weight of dry matter,) even in those cities where water is sparingly used—not only to save the expense, stated by Professor Chandler to be in New York City $48,000 a year, for the removal of this disgusting refuse from those sections where water-sewage is not employed, and which valuable material cannot even be given away on account of its offensive character, but also to return to agriculture an annual aggregate of at least $2,000,000 worth of fertilizing material, enough at the very least, as has been already demonstrated, to make the system self-supporting instead of a constant tax upon the people of that metropolis.

In reference to this question, which has already been pretty widely discussed in our own country, Prof. S. W. Johnson says: "The question of sewage is one of the highest importance; the difficulties increase about it from year to year. The method of Mr. Stanford is the best solution hitherto attempted of this difficult problem."

But, as has been already remarked, the financial aspect of the problem presented, important as it is, and the agricultural importance of this question, than which, probably, there are none greater, are quite secondary to its sanitary considerations. Financially, however, our solution of this question has hitherto only a debtor side, and that side enormous, but for all that, were the problem only solved, leaving but this wasteful, ex-

travagant exhibit as evidence of its unsatisfactory solution, so great is the practical convenience of the present system, so great the revolution sought to be accomplished in the overthrow of water-sewage, or at least in preventing its future increase, that against comfort, convenience, and prejudice united, no arguments merely financial could avail.

67. SANITARY CONSIDERATIONS RELATING TO PRESENT SYSTEM.—Reference has already been made to the official testimony in England. It is from the sanitary stand-point alone that the present system must be supplanted by some other system worthy of the state of science of this age.

The effect of atmospheric oxygen in burning up sewage and purifying polluted streams, so long regarded as though it were an established fact of science, needs further investigation, and it is earnestly to be hoped that this almost universal belief may receive at least partial confirmation. Indeed, every chemist knows that the destruction of organic matter as sewage, without the aid of heat, requires the prolonged action of his most powerful chemicals, and latterly this hitherto almost undisputed view concerning the action of atmospheric oxygen is being most seriously questioned by highest authority. Sir Benjamin Brodie, professor of chemistry, Oxford University, in his evidence before the "Rivers Pollution Commission," says:

"I should say that it is simply impossible that the oxidizing power acting on sewage running in mixture with water over a distance of any length is sufficient to remove its noxious quality. I believe that an infinitesimally small quantity of decaying matter is able to produce an injurious effect upon health; therefore, if a large proportion of organic matter was removed by the process of oxidation the quantity left might be quite sufficient to be injurious to health. To think to get rid of organic matters by exposure to the air for a short time is absurd."

The report of these commissioners appointed to inquire into the best means of preventing the pollution of rivers, among whom was Dr. Frankland, F. R. S., professor of chemistry in the Royal School of Mines, London, and Sir William Dennison, F. R. S., says:

"Our experiments showed that, in fact, no sewage whatever was so converted or destroyed, even after the lapse of a week (in a flow of one hundred and sixty-eight miles, or at the rate of one mile an hour) since the amount of carbonic acid dissolved in the water remained constant during the whole period of the experiment; while, if the sewage had been converted into inorganic compounds, the carbonic acid, as one of these compounds, must have increased in quantity. Thus, whether we examine the organic pollution of a river at different points of its flow, or the rate of disappearance of the organic matter of sewage when the latter is mixed with fresh water and violently agitated in contact with air, or finally, the rate at which dissolved oxygen disappears in water polluted with 5 per cent. of sewage, we are led in each case to the inevitable conclusion that the oxidation of the organic matter in sewage proceeds

with extreme slowness, even when the sewage is mixed with a large volume of unpolluted water, and that it is impossible to say how far such water must flow before this sewage matter becomes thoroughly oxidized. It will be safe to infer, however, from the above results, that *there is no river in the United Kingdom long enough to effect the destruction of sewage by oxidation.*"

Professor Chandler estimates the daily supply of water in the city of New York at 104,000,000 gallons, a quantity which, as he declares, could never be subjected to purification. This river of filth flows into the rivers on either side of the city. Indeed, as Mr. Stanford remarks, "I have always maintained that chemists have been most unfairly treated in this matter. Engineers have too fondly believed that water is the great purifier, and so they dilute the excreta with 365 times its bulk of water, and reduce its value to one penny a ton, and then turn around on the chemist and expect him to reverse the process, pick out the penny, and repay the expenditure. Now, if it were a simple mixture—if it were only to separate the grain of wheat from the sack of chaff—the problem would be difficult enough; but we know the case to be far worse than this; it is the handful of yeast in the sack of flour that we are called upon to extract, and the fermentation of which we are expected to prevent *after* it has occurred. A small portion of dilute sewage, mixed with a large excess of water, soon renders it all equally offensive, and the problem of extracting its value is one which no chemist need ever attempt to solve. The water-closet, with many apparent advantages, and with all our prejudices in its favor, carries an attendant train of evils, which, I am fully persuaded, will ultimately doom it to oblivion."

In a report upon the sanitary condition of several towns in England, Mr. Simms says: "Diarrhœal diseases are increasing in this country. If the diarrhœal death-rate of England generally were only ten times the minimum diarrhœal death-rate, there would be an annual saving in England of nearly 20,000 lives. In the districts which suffer the high diarrhœal death-rates, the population either breathes or drinks a large amount of putrifying animal refuse. The excess of mortality has, in all cases, been coincident with one or other of two local circumstances: the tainting of the atmosphere with the products of organic decomposition, especially of human excrement, or the habitual drinking of impure water."

From a report made to the privy council of Great Britain I quote: "Cholera derives all its epidemic destructiveness from filth, and especially from excremental uncleanliness. The diffusion of cholera among us depends entirely upon the numberless filthy facilities which are let exist, and especially in our larger towns, for the fouling of earth, and air, and water, and this, secondarily, for the infection of man with whatever contagion may be contained in the miscellaneous outflowings of the population. Excrement-sodden earth, excrement-reeking air, excre-

ment-tainted water; these are for us the causes of cholera. Cholera-ravaging here at long interval is not nature's only retribution for our neglect in such matters as are in question. Typhoid fever and much endemic diarrhœa are incessant witnesses to the same deleterious influences."

The London Times, in a recent article on the expected cholera-epidemic, said: "In the first place, the destruction of the excreta from cholera-patients must be insisted on under the heaviest penalties, and a system of inspection adequate to enforce this provision must be organized. Without these preliminary safeguards we cannot hope to resist the enemy with any success. So long as the germs of the disease are allowed to pass through the sewers into the rivers, to be washed up by the tide against our sea-side villages, to be wafted about our streets in the form of impalpable dust, we cannot hope for any good results from sanitary measures of the ordinary kind. Cleanliness, ventilation, above all a pure water-supply, are advantages which cannot be overvalued. But until the germs of disease are systematically destroyed and excluded from any chance of mingling with the air we breathe and the water we drink, nothing will control the ravages of cholera."

It is unnecessary to add to the testimony which the thoughtful investigations of all classes of scientific men have, during the past few years, accumulated. It cannot be denied that conflicts of opinion upon some minor points have arisen, but upon the main question at issue there has been practical unanimity among the hosts of physicists and physicians, chemists and microscopists; and although by habit we have come almost to forget, if not to doubt, the existence of those hidden dangers which environ us, we nevertheless no longer regard pestilence and plague as evidence of Divine wrath, but rather as the legitimate consequences of violation of sanitary laws; and although, as we believe, and not without reason, that pestilence and plague will never again afflict us as in the past, yet the alarming fatality of certain districts, the almost periodical increase in our death-rates, teaches, or should teach us, that our lesson is but half learned, and that we have reason to hope that future generations will refer to our accounts of the devastations of cholera, malarial, and similar diseases, as we now look back upon those fearful records of the plague.

This question, therefore, whether contemplated in its relations to agricultural economy or from a sanitary stand-point, is one of extreme importance, and from year to year presses more and more for a solution. The progress of civilization thus far has converted many of our rivers into sewers and our harbors into cess-pools, entailing enormous waste, and enveloping us in an atmosphere charged with the possibilities of disease. Already many of our larger cities are seriously apprehensive as to their future water-supply, for the polluting touch of advancing civilization and prosperity threatens with defilement the fountain-heads. Corporations and legislatures have grasped the difficult problem, and

are earnestly discussing measures of relief, but there has seemed little hope of success.

To *cure* seems well-nigh impossible, but thus far the efforts put forth have been principally to this end. To *prevent* this state of affairs appears to be the new phase which the problem is assuming, and we cannot doubt, in view of the marvelous and frequent triumphs of science, but that, with the stimulus of many millions of money annually to be saved, with the dread of pestilence and death through continued disregard of sanitary requirements to urge on investigation, this problem also, from this new method of attack being adopted, must soon yield to science, if it, indeed, has not already received in this system of Mr. Stanford a complete and satisfactory solution.

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D.

PHOTOGRAPHY.

C. A. DOREMUS.

VIENNA INTERNATIONAL EXHIBITION, 1873.

PHOTOGRAPHY AT VIENNA

AND

RECENT IMPROVEMENTS IN PHOTOGRAPHY.

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PHOTOGRAPHY AT VIENNA AND RECENT IMPROVEMENTS IN PHOTOGRAPHY.

INTRODUCTION.—1. in preparing a report on "the recent improvements in photography," as shown at the Vienna Exhibition of 1873, it seemed of primary importance to ascertain what new processes of special value had been discovered. To these facts, gathered both at the exhibition and from other sources, it was deemed advantageous to add a review of the developments in the science and art of photography since the World's Fair at Paris in 1867.

2. As greater interest attaches to the novel inventions than to the modifications of either well-known chemicals or apparatus, they will be dwelt upon at length. We will refer to them in connection with the nation on whose list the inventor's name appears as an exhibitor, and thus follow the order of the official catalogue of the exhibition. The course thus pursued will be that taken by most of those who saw this vast display, brought from all parts of the world, in a building under whose dome that of St. Paul's Cathedral could easily be placed.

3. AMERICAN PHOTOGRAPHY.—Immediately to the right of the western portal we met with the collection sent from the United States. The large cases filled with fine photographs produced a marked effect as they caught the eye before it tired with the sight of other things. The American photographers gave in their exhibits some very commendable work. The artistic grouping in the pictures, the poses, choice of representative types of beauty, the clearness of outline and detail, were not surpassed by either Austria, Hungary, or Russia—the only countries that approached them. Practical common sense asserted itself here as elsewhere, and Europeans were willing to acknowledge this superiority. American exhibitors may certainly boast of the splendid panoramic views, of which many were sent, and of those essentially American productions of the photographic art, the ferrotype, and the more pleasing portraits on porcelain. The last-mentioned are beyond doubt as soft and delicate in tint and outline as any known style. Indeed, they excel in many respects the chromo-photographs to be mentioned in another group. It is strange that ferrotypes are not more frequently made in Europe. Peripatetic photographers there employ almost invariably the positive collodion-process.

Besides the specimens of portraiture noticed, there were microscopic and life-size photographs, both of which are justly celebrated. American photographs of microscopic objects are becoming better known and more fully appreciated each year. America is already at the head of

solar, lunar, and spectroscopic photography, thanks to Rutherford and the Drapers. We were sorry not to have seen any of Woodward's microscopic work at the Exhibition. E. & H. T. Anthony had many photographs, chemicals, and apparatus of all kinds on exhibition.

4. Having only arrived in Vienna a day or two before the distribution of prizes, the juries had seen all there was to be seen, and heard all there was to be explained, and both exhibitors and their deputies had taken their departure, leaving no one to give information concerning the merits of chemicals and apparatus, or to show by experiment their manner of working. Looking at collodions done up nicely in bottles gives little information as to the time of exposure they require or as to their chemical composition. The same holds good of many other chemicals; and judgment cannot be given on improvements in apparatus that were not easily detected by inspection through glass cases. It is a matter of regret that it is impossible to give what would undoubtedly be of great interest to many; but, although repeated attempts were made to find exhibitors or their representatives, all such efforts proved unavailing. No one, however, had been appointed to undertake the work of reporting this department, and the endeavor is here made to describe the new processes more fully. With that aim many were studied in actual practical operation.

5. By the plan adopted by the juries in deciding the merits due an invention, no very strict comparison was made with others of the same character, but the intrinsic value of the discovery was regarded, and credit awarded accordingly. It would be impossible for any one to determine whether this or that lens-system was practically the best, unless an experimental research was made, a course evidently out of the question among such a vast number of exhibits as was collected at Vienna.

6. It has been thought wise to append a list of Americans who were recipients of honors. This list is translated from the official announcement of awards.

E. & H. T. Anthony, of New York; for photographic apparatus. Medal of merit.

Charles Bierstadt, of Niagara, N. Y.; for views of Niagara Falls. Medal of merit.

Thomas Houseworth, of San Francisco; for landscape-views. Medal of progress.

William R. Howell, of New York; for portraits, (a collection.) Medal of merit.

W. Kurtz, of New York; for a collection of portraits. Medal of good taste.

James Landy, of Cincinnati; for portraits. Medal of merit.

Leon van Loo, of Cincinnati; for portraits. Honorable mention.

Murbridge, of San Francisco; for landscape-views. Medal of progress.

Henry Richman, of Cincinnati; for microscopical photographs. Medal of merit.

Henry Rocher, of Chicago; for portraits. Medal of merit.

W. Schwind & E. Krüger, of New York; for portraits. Honorable mention.

Scovill Manufacturing Company, of New York; for photographic apparatus. Medal of merit.

Emil P. Spahn, of Newark; for an improved rest. Honorable mention.

Unnevehr, of New York; for photography of reliefs. Honorable mention.

C. E. Watkins, of San Francisco; for landscape-views. Medal of progress.

7. Although the American exhibitors presented nothing that gave evidence particularly of scientific advancement or discovery, there are many scientific men in this country associated with photography. The Drapers were closely connected with the earliest, as well as the most recent, investigations in photography. M. Carey Lea, of Philadelphia, has become widely known for his valuable work, especially in dry-collodion processes and in alkaline development. The globe-lens may also be classed with the many American ideas, although not now a novelty. Our appreciation of European discoveries has shown itself by their being almost at once put in operation, on even a larger scale sometimes than on the other side of the Atlantic. Since 1873 renewed opportunities to judge of this have presented themselves.*

VENEZUELA AND BRAZIL.

8. Only fair specimens of photography giving the scenery and architectural constructions of the country were presented; the portraits of the inhabitants, from the highly-civilized to the most degraded and uneducated natives, however, at once arrested attention. Indeed, some of the latter were taken with the object of furthering the science of anthropology, and now make valuable additions to European museums. There is scarcely a word more that can be said concerning the specimens from these two countries.

GREAT BRITAIN.

9. ENGLAND.—The large and very fine photographs made by the dry-collodion processes produced a strong impression. They were generally artistic studies from nature, comprising fine types of heads, landscapes, and animals, and for the most part not retouched. The photographs made by Col. Stuart Worthley by the use of uranium salts demand especial mention, as do those of Beasley, also made by a dry-collodion process.

10. Worthley's method consists in covering albumenized paper with a collodion containing nitrate of uranium and nitrate of silver. The paper, when dried, is insolated, washed, and fixed as by ordinary means.†

* Large numbers of prints are now made in Philadelphia by the Woodbury and in New York by the Albert process.

† v. Monckhoven, "Traité général de photographie," p. 329.

There were two exhibits by autotype, or carbon processes, pictures mainly of animals. Feneley's magic-lantern views were also excellent.

11. We must accord to England the credit for one great step in advance, especially as the discovery is not only eminently scientific, but also industrial. The process referred to is that of Woodbury. The basis of this consists in making a relief-picture in lead from a gelatine film. Like many inventions, in a great measure it was the combination of known facts to secure a new and happy result. Neither the reliefs produced by the action of light through a negative on bichromatized gelatine, nor the impression in lead of the finest textures or of organic substances, were discoveries of Woodbury, but their arrangement and union is due to him. A sheet of lead in the possession of the writer, from the Vienna Imperial Printing Establishment, bears the impress of a leaf and of a piece of lace, and scratched on the plate is the date, June 19, 1863. In this same collection some of the first carbon prints, made by Tessié du Motay and Maréchal, of Metz, and exhibited in 1867, may be found. Talbot, in 1853, Pretsch and Poitevin, in 1855, made use of bichromatized gelatine for photo-engraving. Dr. Beck exhibited in the "additional collection" proofs made by Pretsch in 1854. Woodbury dates his first patent 1864.* Thus, although the facts were not in themselves original with Woodbury, too much praise can scarcely be given for the exceeding novelty of their application.

12. The outline of this justly-celebrated method having been given, the description of the more practical details, as seen at Messrs. Goupil & Co.'s establishment, near Paris, alone remains. A coating of gelatine, with some such substance as collodion or mica as a backing, is prepared on a plate glass. To the gelatine bichromate of ammonia is added, rendering it sensitive to light. When removed together, say, with collodion, from the glass, it is exposed to the action of light behind a negative, the collodion in contact with the negative. After sufficient insolation, the gelatine is removed and washed in warm water. The appearance of the Prussian-blue mixed in the film shows whether the exposure was long enough or not, by the depth of coloration. This thin film of gelatine, when dry, serves as a relief, from which an impression in soft metal can be obtained. To accomplish this, the film is placed between a steel plate and a sheet of type-metal or lead, and is subjected to a pressure of 500 to 515 kilograms to the square centimeter, in a hydraulic press. The matrix thus produced is hollowed out where the deepest tints are desired; it is therefore the reverse of the gelatine. To obtain from this a positive picture, the lead plate is adjusted in a press; on it is poured a warm solution of gelatine impregnated with coloring-matter, and the whole covered with a sheet of paper, a plate of glass, or whatever is to receive the picture. A slight pressure, one kilogram per square centimeter, is applied, expelling the excess of gelatine, and the mass is thus allowed to cool.

* "Abridgments of Specifications of British Patents." Photography, Part II, p. 97.

At Asnières six of these small presses are worked by one person. They are placed on a turning table, and by the time the sixth is filled and shut down the first is quite cool and the paper ready to be removed. The paper and adhering gelatine are placed in a slightly alkaline bath, thus rendering the photographic print insoluble. For *cartes de visite* a gloss is given, as usual, with a double roller. After the alkaline bath, washing, and drying, the picture may be trimmed and finished as usual. Messrs. Goupil & Co. print large numbers of these, supplying, in one case, a theatrical paper in Paris, weekly, with the portrait of some popular celebrity. This paper is sold for a few sous. The prints on glass, backed by a plate of ground glass, make exceedingly elegant and tasty transparencies. The largest photographs, however, produced by this process are those of Mr. Carbutt, of Philadelphia. Woodbury has made several improvements in his process, enabling him to print as with ordinary oleaginous inks. This is accomplished by adding finely-powdered glass, emery, or some such granulated substance to the gelatine, replacing in part the Prussian-blue. This granulated body is removed, more or less, with the soluble gelatine after insolation, but whatever remains is reproduced in the lead. It thus not only indicates the proper exposure, but gives an inequality of surface, especially to the half-tints, which retains the ink in the pores in a way that a smooth surface, though of the same depth, is incapable of doing. Such uneven surfaces are absolutely necessary where electroplate copies are to be made. When one considers the large proportion of half-tints in portraits from life, the production of pores to hold the ink in photo-press-work of this description is better appreciated. From copper plates, printing is possible both from the high and low relief.

13. Few specimens of photography by ordinary means were to be found, opportunity being scarcely given to judge of the merit of this department of English photography. The want of such examples was, however, a small matter, considering the high distinction awarded by all to the scientific and applied work of the nation. England has always shown herself a pioneer in aiding science, especially where it is allied to every-day life. The number of photographic societies and the acceptance of their researches by the sister societies of other lands shows with what esteem the labors of England are regarded. As these remarks apply only to the British Isles, a word or two on the colonies ranked next on the list will not be out of place.

14. *Mauritius.*—The collections were mostly photographs representing the inhabitants and the landscape-scenery of the country.

15. *New Zealand.*—Here again portraits of the aborigines were plentiful. The science of anthropology can certainly not have suffered from the Vienna Exhibition. There was also a book on the birds of New Zealand, illustrated by photographs.

16. *Queensland.*—A small number of colored photographs only appeared.

17. *Victoria in Australia.*—The views were mainly illustrative of the mines of the country, and were in many cases accompanied by maps. Public buildings and works were shown by a series of views sent by the mayors of the different cities and towns. The scenery of the possessions was also given. As an inducement to emigration, for the furtherance of mining and of other industries, these photographs were exceedingly useful.

18. PORTUGAL.—We find among these specimens numbers of stereoscopic and panoramic views and pictures of art-gems. We noticed that, by the side of old historic relics, a scientific, and at the same time useful, application of photography was presented, the first yet met with. This was a set of meteorological tables, barometric and thermometric registers, produced by means of photography. There were also photographs of the sun. Thus far the art in its relations to the ordinary wants only has been observed; but here were signs of another branch. Portugal has not taken the lead here, but has followed in already beaten paths, and what has been originated in other countries she has adopted, for which credit should be given her.

19. SPAIN.—To demand a display in this art from a country distracted by civil war as it is, even at the present time, would be asking too much. Several life-size photographs of people in the picturesque costumes of the land were conspicuous. Many books were exhibited, illustrated by phototype engravings. Besides these, there were views of landscapes and photographs of peasants, but nothing calculated to attract attention. These photographic specimens may be passed by without fear of having overlooked any important improvements.

20. FRANCE.—Notwithstanding the political condition of France previous to and during the exhibition of 1873, the specimens of her industry sent to all "groups" showed almost unsurpassed merit. She has only one rival on the list of the recipients of grand diplomas of honor in this section.

21. The "Société Française de Photographie" deserves well its fame. This society was represented by an historical collection of photographic science and art. It comprised some of the first essays in Daguerreotypes and many other later processes. This organization has done much to further this important branch of study and research. Its Bulletin contains all new investigations of value. France has done much to aid the progress of carbon pictures. Tessié du Motay's inventions, first exhibited in Paris in 1867, attracted much attention there. Since then several improvements have been made, especially by Albert & Obernetter, of Munich.

22. When in Paris, through the kind introduction of M. Tessié, the photographic establishment of M. Aroza, at Saint Cloud, was visited. This gentleman was engaged in preparing for the publishing house of Rothschild, in Paris, a series of photographs of reliefs of Trajan's

column.* The collodion negatives necessary were taken in the Louvre from plaster-casts of the column, and from these negatives carbon pictures were obtained. For this purpose a thick plate of glass, ground on one side, is covered in a dark-room with a mixture of gelatine, fish-glue, and bichromate of potassa. This sensitive plate, dried in an oven, is now exposed behind the negative, and, after sufficient insolation, washed for a long time in water. The excess of bichromate is dissolved, leaving a relief, the gelatine unacted on by the light, swelling up. From this relief prints may be taken by a lithographic press, the ink adhering to the dry parts, viz, those changed by the action of light. The glass may be replaced by copper as a backing, or an electrotype may be taken.

23. The discovery of carbon printing is variously awarded to Talbot, Pretsch, or Poitevin, but Tessié du Motay and Maréchal, of Metz, were the first to make anything of a manufacture of photographs by the new method. Two to three hundred prints can be obtained from a good relief.

24. The glass photographs produced by another process of Tessié and Maréchal, are exceedingly fine. They are in some cases, as views, exquisite in detail, and, from their being incorporated with the glass, are very durable. Over the collodion picture a glaze is produced by vitrifaction at a high temperature. Still, as these were exhibited in 1867, and not in 1873, more than this slight notice would be out of place.

25. Among the exhibitors we find one whose name is well known to amateurs as the maker of a photographic apparatus that dispenses with a dark-room, the camera being made to play that part. Dubroni has thus given a valuable addition to this department. The productions of various manufactories of photographic paper and of apparatus were noticed. Duboscq had a scientific appliance for illustration by means of positives on glass, a mode of lecture demonstration originated in America, and now being adopted in most European scientific and educational institutions. We found many exhibitors of ordinary photographs, mostly well finished and retouched, and, among these, studies from nature. Stereoscopic views and apparatus and instantaneous photographs of great excellence also abounded. Quite a number of miniatures and enamels, and, at the other extreme, life-size portraits, were placed on exhibition. A process for imitating canvas as a background on which to print oil chromos, several varieties of enameling-powders and exhibits to illustrate their use, and one or two minor specimens of photographic art, may be mentioned. At least a dozen proofs of carbon prints, photo-lithographs, and heliographs appeared, showing clearly the bent of the French mind. Among these, two at least need careful description.

* Erected at Rome, 114 A. D., by the Romans, in honor of the Emperor Trajan. The greatest work of the architect Appolodonis. It is 132 feet high. The bas-reliefs form a spiral around the shaft, exhibiting a continuous history of the military achievements of Trajan. One of the noblest works of this character ever erected.—Ed.

26. In reviewing the Woodbury process, it was stated that the establishment of Messrs. Goupil & Co., at Asnières, near Paris, had been visited, and much information gathered. M. Rousselon, the director of the establishment, a thorough scientific and practical photographer, has been for a long time experimenting with the aim of producing photographically-engraved plates of great delicacy and perfection. This he has achieved, as a glance at any of his work will indicate. He was very polite and courteous in his reception, and showed all of the practical working of the process, but desired for the present, as he was still investigating, to keep the secret of the chemical compounds employed. He first prepares a gelatine film, similar in all respects to the improved Woodbury method, but instead of glass or emery in fine powder, he adds to the gelatine a chemical substance which, under the influence of light, becomes more or less crystallized or granulated, according to the intensity or prolongation of the action of the sun's rays. The grain necessary for engraving is thus produced in the gelatine, and is copied first in the lead by means of the hydraulic press, and then, by galvanoplastic processes, in copper. Thus the dots or lines of engraving are imitated, and a copper plate obtained by this method is used exactly like any engraved plate to print from. A description may also be found in the "Bulletin de la Société Française de Photographie," 1873, p. 14. The February number of 1874 of this same journal contains two specimens made by this very beautiful process. One is a portrait of M. Davanne, who is so well known in connection with photography; the other is the fac-simile of a fan. M. Rousselon kindly showed the copper plate from which M. Davanne's portraits, to the number of 1,300, were printed.

27. This gentleman remarks, in regard to the advancement thus far of photographic art, "There is as yet no photographic process for multiplication, by the aid of some mode of printing, that does not require, as a starting-point, a good collodion negative." M. Rousselon also spoke of the value of a fine collodion, and remarked that he employed the same formula now that he used ten years ago. We have here the corner-stone of the whole structure. Tessié, Albert, Obernetter, Woodbury, and Rousselon all start with collodion negatives, and from these obtain a copy in some substance capable of sustaining the wear and tear of printing in quantity. Several very large copper plates, both finished and in progress toward completion, were seen at Asnières. We trust that his results will soon be given to the public, not doubting that his efforts will receive full approbation.

28. For a long time another aim of photographers has been the production of pictures in color. A great step in this direction is the discovery made by M. Léon Vidal, of Marseilles. Basing his invention on the carbon process, he obtains, as in chromo-lithography, a copy in various tints, by the superposition of one or two pronounced colors. Great care and much time are required in taking the proper negatives. From

these the gelatine reliefs, in different-colored inks, give by their superposition the final print. Polychrome portraits by photographic means are no longer a probability, but a fact.

29. We record here another discovery of M. Vidal, viz, his photometer, by the aid of which, exact exposures, in carbon prints, are obtained. This instrument consists of three series of graduated tints, each covered by a number of sheets of mica, so that the degree of translucency of each of the thicknesses of mica differs in a known ratio from the other two. Each of these series is pierced with a circular aperture, and behind it is placed a sheet of paper sensitized with chloride of silver. The action of light produces a color in the paper similar to that of the tint of the series. Small cells are made, for convenience, having three openings, and the color that appears under the central one, when exposed to light, is taken as the standard. The color of the sensitive paper in the other two should be lighter in the first and darker in the third. Great care is taken in the preparation of these series, especially that the time of exposure should correspond with a normal set.* Léon Vidal's own ideas, and often his words, in regard to these inventions are given in Monckhoven's treatise. In printing the carbon picture, the cell, being placed near the carbon print, shows by its coloration the length of time necessary for insolation.

30. Algiers and Cochin China, as dependencies of France, found representation in the collections.

Thus France contributed to the Vienna Exhibition an historical cabinet worthy of study. From the dawn of the art in the Daguerreotype to the latest improvements, the printing of indelible and polychrome photographs, all departments were illustrated.

31. Switzerland.—The photographic display from this country consisted chiefly of views of its magnificent mountain scenery and portraits of the peasants in picturesque costumes. These specimens were in some cases unusually fine. To the tourist, or even to one only acquainted with Switzerland from books of travel, the scenes were old friends. We noticed among novelties some solar print-proofs, by Benzinger Bros.; also portraits by the same firm. Aristide Boulanger and Carl Cru exhibited enamels, the making of which has now become a new branch of photographic industry. George Simona sent photographs in carbon, illustrations of Dante's Divina Commedia; and Siegwart, photographs burnt into glass by a new process. This last we were unable to get a description of, but doubt if it differs materially from the one mentioned above. With these few remarks we may pass the frontier and descend to the plains of the land of art.

32. Italy.—The clear sky for which Italy is so renowned is a great boon to her photographers. All their pictures, but especially those of Venice, Naples, and Rome, have unsurpassed distinctness. The many

* v. Monckhoven, opus cit., p. 342.

tourists visiting the country make a ready market for the fine views of places of interest, and we find the photographs prepared to supply their wants. The unmounted pictures are a great improvement on those formerly attached to large bristols. The photographs exhibited by J. Rosetti, Antonio Sorgoto, Carl Naja, and the Vianello Bros., in the great rotunda, attracted much notice. It is scarcely necessary to mention other names of exhibitors of this class. Their work shows no advance beyond what has been seen for some years past. We find, however, that fac-simile copies are now produced by photographic means, thus giving a new impulse to the art. Old manuscripts, and articles valuable from artistic or historic interest, are now given to the public, as far as possible, in accurate pictures. Four or five such exhibits were seen; one series was taken by photolithographic means. Among these may also be classed the reproductions of manuscripts and sketches by artists, now so largely used in the study of art. J. Mamoli displayed photographs intended to be placed on majolica ware.

33. Two exhibits of "aletoscopes" were sent. These are large cameras for views, one large lens taking the place of the two of a stereoscope. Peter Bertoja and Anglioni & Co. sent some fine photographs which the Catalogue says, were taken by moonlight. The views, especially those of Venice, produced very pleasing effects. We presume, though, that the Catalogue is in error, as these imitation moonlight scenes are taken by sunlight, exposing the plate much less than the required time for an ordinary negative, and obtaining a photograph of the sun's disk, thus introducing what one would suppose to be the moon.* Professor Borlinetto, of Padua, sent a treatise on photography and photographic work.

The Italian department was the most ill-arranged, in some respects, of all countries. There were many exhibits catalogued that it was impossible to find, even with the assistance of the custodians. The above treatise was one of them. J. Matthieu sent essays of a new method of reproducing the firmament, and some other improvements. C. Massano sent a new method of systematizing and adjusting photographs. Neither of these exhibits could be found, the circumstance thus adding still more to the difficulty of giving Italy her just dues. P. Lombardi presented carbon prints, and L. Lamarra photographs taken by artificial light. Lauro Benaventura produced excellent life-size photographs painted in oil; also views and small photographs; and, to finish the list, P. Seveso, photographic apparatus.

34. The science of photography is cultivated by the "Photographic Society" of Bologna. This society sent a few specimens; nothing, however, of note. The principal, and the finest exhibits of Italy, were to be found in the rotunda; but the arrangement of the rest cannot be commended. Either the objects could not be found, no one could direct the visitor, or else their positions prevented close inspection.

*v. Monckhoven, p. 262.

35. SWEDEN.—Beyond the few exhibits of ordinary collodion negatives and positives on albumenized paper, little was observed. But one set of photographic engravings, and a series of photographs on canvas as a sketch for artists in oil, formed the rest of the specimens. Nine firms were represented.

36. NORWAY.—This country was behind Sweden in the number of exhibits. Views, peasantry in costume, and a few portraits, constituted, of course, the larger share. There were some photolithographs of old Norse manuscripts, which were interesting to antiquarians. The Norwegian scenery is very wild and beautiful, and many views reminded one of Switzerland.

37. DENMARK.—Here there was more to attract attention than in the collections of its neighbors across the sea. There were quite a number of fine photographs; in all, seventeen exhibits. The views and costumes, as usual, a necessity. There were two series of rather good photolithographs, the chief army staff sending maps and charts prepared by this means. One exhibit of zincographs was also seen. S. Nielsen sent several fine micro-photographs. Lönberg, of Copenhagen, presented a fine collection of anthropological studies from nature. This was one of the few especially prepared for illustrating the science of anthropology.

38. BELGIUM.—Among the articles here placed on view must be noticed the large percentage of carbon prints over that of other countries. F. Devon, Géruset Bros., and Joseph Maes produced some fair, even excellent, carbon pictures. W. Damry exhibited a collection of portraits, the principal claim to notice being their exceeding cheapness. For 30 to 40 centimes, (6 or 8 cents,) and for from 1 or 2 up to 50 francs, various grades of photographs could be purchased. Enamels made by Guyot, an assistant of Hochmuth, deserved attention. Adolphe Meyt, of Ghent, had several large photographs of the moon. The astronomical photographs were taken by a 9¾-inch reflecting telescope, and then enlarged by diffused light. They were in every respect worthy of inspection.

39. Among the Belgians, although for some reason or other not an exhibitor, must be mentioned Dr. v. Monckhoven, whose "Traité Général de Photographie" has given much information, particularly in the preparation of the descriptions of new processes in this report. Reference to his work has been made both on subjects where other authorities could be quoted and also where, from the impossibility of obtaining information at Vienna, research concerning methods was necessary. The book contains much that is interesting to the general reader, and as the author is the inventor of several scientific and practical processes, it contains much of value for the specialist. The instruments described and pictured by him commend themselves from their simplicity and convenience in construction.

40. NETHERLANDS.—The views and portraits made by J. Kalkow, the copies of the old masters by E. R. Eybrink, and the phototypes of M. Verveer were about all that was commendable among collodion pictures.

Dr. F. J. Asser sent proofs illustrating a photolithographic process, some of which looked very well. The Royal Topographical Institute exhibited maps, made by photographic printing, of East Indian possessions. Besides these, there were also chromo and photolithographs. Binger and Chits, of Harlem, exhibited photolithographs, photograms, and heliophototypes. The specimens from Holland were very creditable, but deserving of less attention than those from Belgium.

41. GERMANY.—The large number of publishing-houses in this country creates a demand, in many cases, for photographs as illustrations, instead of wood-cuts or engravings. We find, therefore, the celebrated names of J. G. Cotta, of Stuttgart, Bruckmann & Co., and many others connected with this branch of the art. Alexis Jahn sent specimens of inking-rollers for photolithographic and engraving purposes. But we will, for the sake of conciseness, group the exhibits, thus classifying the photographic work of many under one head. There were four or five firms whose specialty was the photographing of interiors of architectural structures, the publishing-house of Gerlach taking the lead of these. Quite a number of life-size or very large photographs were shown. They were taken by different processes, none of which were new. One firm had an enlarging-apparatus on exhibition with the photographs.

42. An important branch of industry has arisen in the application ot photography to the decoration of porcelain. The silver in the collodion is changed, if necessary, to gold, platinum, iridium, &c., by immersion in baths of salts of these metals, the collodion then transferred to the porcelain and protected by a glaze; the wares are subjected to the action of heat in a muffle. The ornaments are thus easily produced, the color varying according to the metal employed. A. G. Steuder, A. Lisner, and H. Greiner & Co. had some excellent specimens effected by similar enameling-processes. Germany has of late years furnished the world with large quantities of scientific apparatus and fine chemicals. It was not surprising, therefore, to have found many exhibits of this class of articles.

43. Three firms make a specialty of collodions. Grabe & Co. sent an iodized collodion of their own invention; Dr. Franz Schintzer & Co., a collection of photographs taken with Greiner's "universal collodion;" J. Herzog, collodions and varnishes; F. Beyrich and J. Moser manufacture stereoscopes. Brandt & Wilde, Hessler, J. F. Schippang & Co., Bente & Stolze, all manufacture apparatus and chemicals. Among the makers of optical instruments, particularly, the industrial establishment of Rathenower and C. F. Usener may be mentioned. Dr. J. M. Löwe and G. Wachmuth produce photographic papers. F. X. Rückner was represented by a tent of his own invention, useful in out-door photography. W. Spindler, of Stuttgart, sent a number of small boxes containing photographic apparatus, by means of which, from accompanying negatives, prints could be obtained. Among those who exhibited stereoscopic views, fine photographs of scenery, costumes, panoramas,

statuary, works of art, and studies for artists, special mention of any one firm is unnecessary.

44. The next class comprises many of the carbon prints, the photolithographs, and the heliotypes. So many names for one and the same article, or process, are given that the subject becomes confusing. Eight or nine firms, occupied with this kind of work exhibited in many cases the collodion-process photographs as well. Quite a number of names are associated with painting in oil on photographic outlines. The reproductions of oil-paintings, fac-similes of art-gems, are properly noticed here. Only one set of microscopic photographs came under our observation. These were made by Dr. Gustav Fritsch, and having been prepared, evidently, with great care, deserved attention. There are two classes of microscopic photographs, one so small that they must be looked at under a microscope to become visible, the other prepared by the enlarging power of a solar microscope, the object therefore greatly magnified in the photograph. The specimens of Dr. Fritsch belonged to the latter class. They had reference to medical science. The photographic laboratory of the Royal Industrial Academy of Berlin gave evidence of its practical teaching, in photographs of scientific apparatus and of artistic subjects. L. Harnecker presented photographs taken by artificial light. A. Meydenbauer, an architect, sent views of buildings and landscapes obtained with dry plates in a "photographic theodolite." The surveying commission of the Grand Duchy of Mecklenburg had a series of charts and maps executed by the aid of the Albert process. These last form one class of applications of photography to scientific uses. We have now to review the body of the exhibits of this country, but only in so far as to commend the photographers of Berlin, Hamburg, Stuttgart, and Munich, with one or two others of smaller cities. Some photographs were exceedingly well taken, others might better have remained at home. Berlin was, on the whole, well represented in every line, more of the chemicals and apparatus being sent from there than from any other city.

45. We may now pass to the consideration of the most interesting exhibits, those showing the new processes, and find in them much to admire. Germany has, as we hope to show, made great steps in advance. Romain Talbot, of Berlin, presented solar prints and apparatus for obtaining them. Dr. E. Jacobsen, also of Berlin, exhibited colors and proofs of a new process. F. H. Dethleff had some illustrations in an album, and chromo-photographs. Most of what were called chromo-photographs were not photographs in colors, like those of Vidal, already described, but were painted by hand, and rendered transparent by oil or varnish. Under this first photograph, made to adhere to glass, a second, painted somewhat differently, is placed, producing a very pleasant, soft appearance when viewed by reflected light. Many such were seen in the Hungarian department, and will be referred to in that con-

nection. George Rotter & Co. sent samples of photographic papers. The more important processes now demand attention, and we shall take up that of Albert first, as some of the others resemble it.

46. THE ALBERT PROCESS.—This process, invented by Joseph Albert, of Munich, received the grand diploma of honor, and certainly the beauty of the prints obtained is almost unsurpassed. The process itself differs but slightly from those of Poitevin, Tessié du Motay and Maréchal, and others. But it is these small differences that render the results so widely diverse. The secret of the method seems to lie in the preparation of an insoluble first coating of gelatine on the glass, from which the impressions are obtained. A finely-ground glass plate is covered with a mixture of gelatine and bichromate of ammonia, dissolved in water, to which mixture finely-beaten white of egg is added. This, being dried in the dark at 30° C., and exposed afterward to light, the gelatine-surface against a black cloth, is rendered insoluble. The excess of bichromate is removed by washing in cold water and the plate allowed to dry. The second coating of gelatine is next given. This is produced by covering the first with a complicated mixture of gelatine, fish-glue, albumen, bichromate of potassa, nitrate of silver, bromide of cadmium, and iodide of cadmium, all dissolved in water; and of lupuline, gum benzoin, and balsam of Tolu, dissolved in alcohol. The method of preparing these solutions, and the quantity of each ingredient, is given by v. Monckhoven, p. 351, Bierstadt Supplement to the Photographic Times, June, 1875. A thick or thin coating is made with this mixture on the first, according as portraits or line-engravings are desired. The thicker the layer the more perfect the half-tints, so that this is specially applicable to portrait-printing. The plate thus prepared is exposed behind a negative for a quarter of an hour; it is then washed in lukewarm water, and dried in a vertical position.

Before proceeding to print from the plate, it is placed, for four or five minutes, in cold water and glycerine, wiped with a sponge, and then rubbed with a piece of oiled flannel; and again the moist sponge is passed over it. The next step requires the exercise of great skill by the workman, in order to "cover" the plate uniformly by means of a lithographic inking-roller. The impressions resulting are of the finest quality. Either the photographs on paper prepared with solutions of common salt or albumenized paper can be imitated. A much greater number of impressions can be taken from the plates than by most other processes approaching it in the materials used. For more details we must refer to the many works on photographic manipulation. We have already mentioned that the surveying commission of Mecklenburg had adopted this process for the work of such a department, thus showing its practicability. Enough has been said, however, to demonstrate the value of the discovery, and the recognition of its merits at Vienna is surely a fair indication of its excellence.

47. Friedrich Bruckmann's publishing-house, in Munich, issues large

quantities of the handsomest photographs. They exhibited many elegant specimens in the rotunda, and now prepare many by Woodbury's process, already described under England. W. Grüne, known from his invention of gilding and otherwise decorating porcelain, had exhibits of all kinds of papers for photographic use, mixtures for taking the reliefs in photographic impressions, and other chemical compounds brought into demand by the latest inventions. We will turn our attention now to a very neat, but rather difficult, method, which gives, notwithstanding, most excellent results.

48. The firm of Adolphe Braun, of Dornach, Alsace-Lorraine, publish photographic prints, mostly copies of the works of art in the museums of Europe, and comprising the statuary, oil-paintings, and sketches of the best artists. They may be had in several colors, imitating the red or black pencil-marks of the sketches, for instance. The pictures are well mounted, and, what is more, are inexpensive. Certainly they are the most durable of any given to the public. Through the kindness of M. Braun's son, now established in Paris, the Franco-Prussian war having transformed Dornach from a French into a Prussian town, the process, as there carried on, on the largest scale, was explained. All the operations that admit of it are done mechanically. The method is as follows: A negative is obtained by the ordinary collodion process. Paper covered with a mixture of gelatine, coloring-matter, and bichromate of potassa is exposed to light behind the negative. On removal from the copying-press, a layer of caoutchouc is placed on the gelatine. This is then washed in lukewarm water, and the paper and part of the gelatine thus removed. When the remaining gelatine is dry, it is attached to the paper backing by means of a thin layer of gelatine spread on the latter, and the caoutchouc is dissolved off by benzine. Most beautiful carbon prints are thus obtained. The process requires nice manipulation and great care, but does not necessitate an outlay fo presses and their appurtenances.

49. The last of these important processes is that of J. B. Obernetter, of Munich. This is very similar to that of Albert. The first part viz, the preparation of the two coatings, is almost identical. After the exposition behind the negative, however, Obernetter covers the gelatine with impalpable zinc-powder, and then heats it in an oven to 200° C. The plate is then subjected to the action of dilute hydrochloric acid and washed, and it is thus rendered capable of receiving an ink on those parts where no zinc is attached. Obernetter thus obtains a plate from which more impressions can be taken than from even that of Albert. The grain produced in the picture is also of great advantage. The greater proportion of the photographs of the Vienna Exhibition was taken by this firm. M. v. Monckhoven gives in his work two pictures, one prepared by the Woodburytype and the other by this heliotype process of Obernetter. Three thousand two hundred copies were made of each. Both are exceedingly fine, and it is next to

impossible to decide which pleases the most. There is scarcely any necessity of going more minutely into these methods. Those who desire practical details do not look for them in reports of this character. We cannot pass on without crediting Germany for the three strikingly good and useful inventions, at least, that appeared upon her lists.

50. AUSTRIA.—This being the country under whose auspices the great undertaking, of bringing the products of human industry of all nations together, was organized, we were not surprised to find the number of exhibitors in this as well as in other departments greatly exceeding that of any other nation. Indeed, three times as many makers had photographs for exhibition in the Austrian section than in any other. We found, nevertheless, that a very large proportion of these were no more than the specimens of ordinary photography, with, of course, all the care possible bestowed to make the specimens attractive.

The combined collection of the Photographic Society was well worth close inspection. Luckhart seems, among the many names, the most deserving of praise. The three firms of Angerer sent really fine portraits, Viennese beauty materially aiding the artist. There were many exhibits of photographic-stock articles, chemicals, and paper. Kraziwaneck has a wide reputation, and any one visiting his establishment would become acquainted with the facts accessary to the prosecution of most, if not all, new processes. Although not in this group, Plössl, of Vienna, the celebrated microscope-maker, had several large microscopic photographs in his case in the rotunda. J. C. Steuer presented some photographs and transparencies on glass. These produced both novel and pleasing effects. F. Kohler had similar photographs on exhibition; also photographs imbedded in pressed glass. These last-named goods have become quite a staple fancy article. J. Leth produced specimens of pyrophotographs, photographs for wood-cuts, and phototypes, but no mention was made of the employment of any but well-known processes in their manufacture. G. Märkl made a specialty of photographs on porcelain and of solar prints. E. Matzenauer showed photographs printed from "magnetized matrices;" in other words, from electrotype plates, as is now often done. J. Pizzala exhibited a collection of stenographic work and accompanying photographs: H. Schwertfeger specimens of photography as applied to wood-cutting. The state department of railroads sent a series of fine views of the principal railroad-buildings and of works in engineering. These were valuable, as aiding this branch of photography. Count Johan Wilszek presented views of the polar regions, taken on one of the last expeditions. Among the Austrians who placed pictures in the rotunda were Löwy, J. Gertlinger, and Adele Perlmutter.

51. But the chief interest centered in the "additional exhibition," collected with the view ot representing the history of photography, and composed of exhibits from Austria. This was only one of a series, each "group" having its progress exemplified. Advantages for minute and

careful study and comparison were thus given. When these minor points of this grand exhibition are taken into account, as well as what the casual observer would see, the true magnitude and importance of this world's fair fully appears. Leth, of Vienna, placed on view carbon prints, photo-lithographs, and "*staubfarben bilder*," which means, as nearly as we can translate it, carbon prints prepared with pulverulent colors. The imperial court and state printing-establishment, among other curiosities, sent a photo-galvanic impress, made by Pretsch, in 1854. Paul Pretsch himself exhibited photo-galvanic proofs. His process certainly has great claims of being the first where bichromate of potassa and gelatine serve as the sensitive body. The reliefs are easily copied by electrotype in copper or other metal. To Dr. Beck, of the imperial printing-house, the collection of the exhibits mentioned above, as well as those on photo-lithographic work produced in 1857, was due. To Anton Martin, librarian of the Vienna polytechnic high school, the exhibition was indebted for many historically interesting specimens. A lithographic copy of a Daguerreotype, a hand-book of photography, and a paper negative, made in 1842, were among the collection. A photographic portrait and a Daguerreotype, made by Anton Martin in 1841, were placed on exhibition by A. Reissinger, of Vienna. A. Löwy, also of Vienna, gave practical illustrations of solar press-work. Dr. Hoenig sent photographic correspondence of historic value; and C. Reiser sent old Daguerreotypes. Finally, A. Leth, of Vienna, presented a collection composed of chloride of silver pictures on glass, heliotype proofs, and plates also of glass, while there were series of pyro-photographs, of the necessary chemicals and appliances used, and demonstration of new processes. We thus have photographic data ranging from the early essays on silver plates to the latest improvements in photo-press-work. Under the head of France a similar combination was noticed. There, however, it was no specially-prepared collection that brought all the parts together into a systematic arrangement, but each exhibitor presenting the work of his own department; a complete history was the undesigned result.

52. HUNGARY.—The collections sent by this country were different from any so far seen, in containing a proportionally greater number of colored photographs. A. Schievert placed quite a number of chromo-photographs on view. They were particularly agreeable from their softness of outline, and as representing the handsome Hungarian women. Professor Koller also exhibited similar portraits. There were many pictures of people in costumes of the nation, and they were generally well taken. R. Geschwindt presented photographs on canvas. S. Herter, among other things, a self-acting washer for photographs, which was, however, not in operation. But one firm had photo-lithographic impressions. There is no necessity of dwelling longer here. The most important work of the Austro-Hungarian Empire has been alluded to, and Hungary has given, in many respects, but a supplement to Austria, filling

one or two vacancies. The Hungarian photographers were in many instances not behind their Austrian, or, more particularly, their Viennese neighbors.

53. RUSSIA.—In this collection an unusually large share of fine photographs was displayed. The merit evinced was very decided. The artistic poses, the fine retouchings, where necessary, and the general effects were all striking. The names of Max Fajans, W. W. Lewitzky, and C. C. Röttger were particularly noticeable from their exhibits of skill. The imperial Russian department for the preparation of state papers has made extensive application of heliographic methods. C. Brandel, in a pathological atlas, also gave illustrations by phototypes. One or two firms exhibited fine chromo-photographs, not unlike those of Hungary. Lewitzky had phototypes on wood, glass, and steel. Others placed miniatures, apparatus, and accompaniments before the public. J. Metschkowsky presented a new method of obtaining negatives, with proofs to illustrate it, but although several attempts to get an explanation of its peculiarities were made, none was successful. It is not too much to say that the greater part of these photographs, representing the state of the art in Russia, demand the highest praise. Few photographers from other lands can boast of the production of pictures superior to them.

What remains to be said of the exhibits of other countries not already given will be summed up in a few words. There are many nations unrepresented in the group, a list of which will be appended.

54. GREECE.—Only one or two series of views of buildings, scenery of the country, and similar subjects, were sent.

55. TURKEY.—Nearly the same statement applies here. We had really expected more, especially from so large a metropolis as Constantinople.

56. ROUMANIA.—The sole exhibit was that of a German, who, in sending views of his brewery, gave a clue to his nationality.

57. EGYPT.—Two collections, photographs by foreigners resident in the country, were the only representatives.

58. JAPAN.—Many interesting views were given, but nothing that denoted any special progress. In all such countries the advancement consists in the fact of photographs being taken at all. China sent nothing, although both English and American residents have long since introduced the art.

59. SANDWICH ISLANDS.—Here, under the influence of commerce photography has also become possible. Views and portraits were among the exhibits. Of course the natives appeared in the latter.

60. URUGUAY.—All that was here presented were views of Montevideo.

61. BRITISH INDIA.—The civilizing power of the West has pronounced itself markedly here. More appeared than the simple landscapes, with now and then a portrait. Nicholas & Curths sent photographs of the "bower-plants" of South India, also of the natives; Capt. Ross Thompson, photographs of the antiquities as well as of the scenery. The Art

School of Madras and Capt. R. Traill presented similar collections; D. H. Sykes and Marrayer Shewshunker, views of the temple of Ambarnath and details of its architecture. Dr. Leitner displayed photographs of Buddhist architecture, and scenes near Lahore; and the Indian Museum, London, views of all parts of India. Thus many of these were architectural studies, and in part subjects demanding the antiquarian's attention. But alongside of these we found science asserting herself. Colonel Thuillier, of Calcutta, not only exhibited collodion photographs, but zincographs, colotypes, and topographical views.

62. To the long list of nations already given we would add those who sent no exhibits of the photographic department of Group XII, which, according to the classification, included "the graphic arts and industrial drawing." There were, of course, many photographs scattered through the other departments—views of factories, of schools, and government institutions—but, as they did not appear under this section, it was impossible to note them.

The Republic of Salvador, the Bahama Islands, Cape of Good Hope, Ceylon, Jamaica, Trinidad, West African British Possessions, Caucasus, Tunis, Morocco, Persia, China, Guatemala, and Chili were all unrepresented by any photographic display.

For a more complete comparison of the number and character of the exhibits from each country, a table is appended to this report. In classifying, it has often been difficult to decide to which group the specimen should belong. Many persons sent two or more styles of photographs, and, where this was the case, judgment was given in favor of the novelty or importance of the process employed. Only those discoveries have been classed as novel that admit of extensive application. Many new methods, intended for specific use, have been spoken of, and rank in the table as relating either to science or to art. The "additional exhibition" has been omitted, since it forms but one head—the historical. Sufficient notice has been given to it in the proper place.

TABULATED REPORT OF THE PHOTOGRAPHIC EXHIBITS AT THE VIENNA EXHIBITION.

Country.	Photographs by collodion-process.	Landscapes and stereoscopic views.	Life-size photographs.	Microscopic objects.	Apparatus, chemicals, paper, &c.	Recent improvements of importance.	Applications of a scientific character.	Applications of an industrial character.	Copies of oil-paintings, manuscripts, and art-gems.	Photographs in porcelain, enamels, &c.	Dry-collodion processes.	Views of strange lands, peoples, costumes, &c.	Photographs in carbon.	Heliographic pictures.	Photographs by artificial light and moonlight.
United States	9	2	1	1	3										
Venezuela	3	2							1						
Brazil	2														
England	13	2	2		1	2	1				1				
Mauritius												1			
New Zealand							2					7			
Queensland	1														
Victoria, (Australia)		14					2					1			
Portugal	3	1					1		1						
Spain	7	3					1	2	1			1			
France	12	4	1		5	2	2	5		5			2	2	
Algeria and Cochin China		2													
Switzerland	12							1		3		1		1	
Italy	20	6	1		3	3	2		3	1			1		3
Sweden	9							2							
Norway	1	1							1						
Denmark	15	1		1			1	2				2			
Belgium	2						1			1			3		
Netherlands		1						4		1					
Germany	50	8	7	1	15	9	3	6	7	4		1	2	6	1
Austria	141	2			5		2	5	1	3					
Hungary	24	4	1			1		3	1				2		
Russia	8	2			1	2	1	3		1			1	1	
Greece		2													
Turkey		5													
Roumania		1													
Egypt	2														
Japan	1														
Sandwich Islands	1														
Uruguay		2													
India		8						2				1			

63. In closing this report, we would call the attention of all interested in the useful arts, to the decided advantages to be reaped in the new fields opened by photography. It would no doubt greatly add to the usefulness of governmental documents should they be illustrated, as they can be in many cases, by photo-engravings. There are many problems yet to be solved, it is true, but the efficacy of some of the latest inventions has been shown in the most satisfactory manner at Vienna. In this connection, therefore, we would refer to the English, French, German, and Austrian exhibits especially. It needs but the patronage of a liberal public to assure the success of processes already in operation on this side of the ocean.

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MEDICINE AND SURGERY.

RUPPANER.

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MEDICINE AND SURGERY.

1. GENERAL OBSERVATIONS.—The Vienna Universal Exhibition of 1873 claimed to represent, in the fullest sense of the term, the culture and progress of the present. The mission of Paxton's glass palace of 1851, and the triumphs of the first capital of Europe in 1867, were to be surpassed in 1873 by a colossal undertaking upon the Prater.

Could the science of medicine with its correlative branches be included on such a field of contest? The projectors of this great enterprise decided this question in the affirmative; but not without opposition from some members of the profession of medicine, whose pleasure it is to advance theories but to despise the practical.

But when we consider the intimate relations medicine bears to all that concerns the well-being of man upon this earth, can there be any dispute whether this, the most popular of all sciences, requiring and exercising the noblest gifts of man in the cultivation and practice of its various branches, ought to occupy the place of honor at such an international exhibition?

There was another potent reason for the appearance of medicine as a factor upon this theatre of the world. Medicine is truly international in its character, and in this, its international character, it was most worthy to be represented, in so far as possible, for the advantage and study of all interested therein. The objection that a science ought not to be placed side by side with the products of trade or commerce, to be lowered to an equal level, must be put to rest with the observation that in Austria, as well as in the German Empire, the calling of physician is placed upon the same level with other trades; that is to say, medicine is by law placed in the category of a business calling.

We may now inquire: "What was done at Vienna to provide a home in the Exhibition for this popular science, after it had been invited to enter its arena for honorable competition?" Strictly speaking, next to nothing had been done, as if the invited guest had not been expected.

2. CLASSIFICATION.—Examine the twenty-six groups into which the entire Exhibition was divided. Of these, not a single one was exclusively reserved or dedicated to medicine. Group XIV, scientific instruments, offered in the third section a modest space for surgical-technic, and surgical instruments. How insignificant a part, in comparison with the entire body of the science of medicine!

In Group XVI, the Army, section 3 had been reserved for "Sanitary Management of the Army." The remaining departments or branches of medical science were forced to find, willing or unwilling, a dwelling-

place in the remaining groups and sections. That by this arrangement often the most comical contrasts were produced may easily be imagined.

It is true, for the display of "Military Sanitary Science," a special pavilion had been built—one of the most instructive and interesting places of the entire exhibition to visit, both for physicians and laymen. But even the construction of this pavilion was accompanied with the greatest difficulties.

This faulty arrangement was the more to be regretted, since there was offered here to the physician and student in all branches of science such a mass of instructive material, that more could be learned and practically brought to the test in a few hours than can be learned from thick folios during entire weeks by the most devoted and conscientious student.

Proper classification reduced to practical simplicity is the first desideratum—the *sine qua non*—of an exhibition. As is well known, the sections of the different nations at the Vienna World's Exhibition were arranged alphabetically. Although there were many separate and special exhibitions upon the Prater, yet each nation displayed within the Exhibition Palace proper, and within its allotted space, its own objects under the twenty-six groups or classes into which the whole had been divided. These groups were again subdivided into sections. To enumerate these twenty-six groups would be superfluous labor. Suffice it, then, to state that most of the objects pertaining to the various branches of medical science were exhibited under—

GROUP XIV. Scientific instruments; section 3, surgical technic.

GROUP XVI. The Army; its management, &c.

GROUP XVIII. Engineering.

GROUP XXVI. Education; instruction. Section 3, technical high schools; universities.

GROUP III, Chemical Industry; GROUP IV, Food; and GROUP XII, Graphic Arts, contained also many objects of special interest pertaining to the science of medicine

It is, therefore, easy to perceive, from the above classification, with what difficulties the inquirer in this special department had to contend. He was obliged to travel from one extremity of the Exhibition Palace to the other, and then to go through again each and every group, in order to find what he was searching for. All this trouble might have been avoided had medicine and its correlative branches formed a separate group, and had all the objects contributed by various nations been placed together. What a wealth of information could have been thus gathered at a glance!

A few examples will illustrate how different nations, or rather those intrusted with the care and arrangements of their goods on exhibition, will interpret different principles of classification. In the Spanish section I found exhibited under Group XIV, devoted to Surgical Instruments, tape-worms in spirit. One country exhibited anatomical prepara-

tions under Group XIV, viz, Surgical Instruments; and another country presented the same under Group XXIV, Education. Germany had placed artificial eyes under the group of Scientific Instruments. Sweden assigned the same to Group IX, Earthen and Glass Wares, near ovens and a variety of stone and clay wares. Group XXVI, Education, of Sweden, formed a complete variety store, containing at the same time sewing-machines, artificial flowers, artificial teeth, respirators, preserves, bed-covers and woolen stockings. And these are not the only examples that might be mentioned. Yet all this Babel-like confusion might have been avoided had the projectors of the exhibition placed medicine in a separate group, and assigned it an independent pavilion.

3. Exhibits.—These contributions, sent by the different states, presented the greatest contrasts. Non-European nations were either not represented at all, or were notable only through the paucity of the number of objects exhibited. The few contributions from the United States of America will be duly referred to in their appropriate place.

Among European states, Austria occupied the first rank, both in quality and quantity; her universities collectively, and professors who have given these universities a world-wide celebrity, both as teachers and authors, vied with one another, to place before the judgment of the scientific world all that could be brought to bear to illustrate their devotion and achievements in a noble calling. Next in order figured the German Empire, if not through its universities as Austria had done, at least through its contributions in industries intimately connected with medical science.

Russia, last but not least, was represented by the universities of St. Petersburgh, Kiew, Kharkov, and Warsaw. Innumerable catalogues, pamphlets, price-lists, monographs specially prepared and written with reference to the objects exhibited, were of great value. But of greater value than all these combined were the able and exhaustive contributions from the pens of Drs. Benedict, Schintzler, Vogel, and others, which appeared as supplements to the Vienna New Free Press, from time to time. These contributions served as reliable *cicerones* to the inquirer, often nearly lost in bewilderment among the innumerable objects scattered over such an immense area.

4. Special Branches of Medical Science Represented.—*Anatomy*, exhibited under Group XXVI, "Education."

Austria, Russia, the German Empire, and Italy, brought the largest contributions in this branch. Foremost may be mentioned the name and the works of the renowned Professor Joseph Hyrtl, of Vienna, who exhibited by six distinct groups, one of which alone, that of illustrating the organ of hearing, had cost him fourteen years of uninterrupted labor. All groups were subdivided into sections; altogether they contained several hundred anatomical preparations and specimens, filling a catalogue of 45 pages, the whole representing the principal branches of anatomical

technic in the most complete form possible. To indicate how much the labors of Professor Hyrtl are appreciated all over the globe, it need only be mentioned that his work, "The Anatomy of Man," has passed through twelve editions, and has been translated into seven foreign languages, of which 36,000 copies have been sold. Words fail to describe the wealth of knowledge and research brought to our notice in this collection alone. Weeks were insufficient to study it even superficially. It was worth a trip across the ocean to see it.

Professor Politzer, also of the University of Vienna, presented a fine collection of anatomical preparations of the anatomy of the ear, and a second collection, illustrating the pathological changes of the tympanum. The collection of instruments of the same professor, used in the treatment of diseases of the ear, was most complete.

The contributions of Professor Teichman of Krakow, Professor Heschl, of Graz, of Professors Leuhossack and Margo, of Pesth, although most meritorious, must be passed over for want of space.

Germany, to our surprise, appeared in this department only in its superb collections of microscopic preparations, sent by several firms occupied in this branch of industry.

France was, as usual, represented by admirable anatomical preparations, sent by Charles Bourgoyne, of Paris.

Russia stood next after Austria.

Prof. W. Betz, of Kiew, contributed a collection of 2,400 anatomical objects, illustrating the anatomy and pathology of the brain. What labor, what devotion in this, the work of a single physician!

Italy sent nothing direct in anatomy, but in its correlative branch, the art of embalming—the preservation of the cadaver—the contributions of Professor Marini, of the University of Naples, and of Professor Brunetti, of the University of Padua, deserve special mention.

Professor Marini exhibited three methods of preservation of the human body after death:

1st. The preservation of the body after the manner practiced by the Egyptians, wherein the subject has all the appearance of a mummy.

2d. The process of petrifaction, by means of which parts of the human body can be transformed into a solid mass, hard like stone; which mass may be cut and polished till the surface resembles a fine mosaic, and reminds one of polished marble. In being cut, the component anatomical parts of the mass can be easily recognized.

3d. The process of embalming by means of which the entire cadaver, or parts of it, can at any time be brought back to its former degree of elasticity and softness, as well as its natural color restored. This method was demonstrated upon a forearm, preserved since 1868. The hand was fresh, of natural color, elastic, easily movable, resembling in all respects the hand of a person only lately deceased. The remaining part of the arm, on the contrary, was dry and shrivelled like that of an Egyptian mummy.

This method of Professor Marini can be applied in different degrees of intensity, according to the period it is desirable to preserve the body. The expense is in direct ratio to the length of time it is desired to preserve the body. To embalm a corpse for two weeks costs about half a florin, or twenty-five cents of our money. The method itself is kept secret by Professor Marini.

Professor Brunetti, of Padua, also exhibited his process of embalming, in which the use of the air-pump is the most important factor.

Considerable interest was created in Brunetti's method of cremation, now so generally discussed. The ashes of a man fifty years old were exhibited by Brunetti, which weighed less than two pounds, to which ashes the body was reduced in four and a half hours, at an expense of one hundred and sixty pounds of wood, for which one florin and twenty kreutzers, equal to fifty-five cents of our money, had been paid.

Scattered through the exhibition were many examples of microscopic anatomical photographs, placed generally under Group XII, Drawing.

The firm of Schwing & Krueger, of New York, exhibited some remarkably fine microscopic preparations of healthy lungs, as also some illustrating the various stages of phthisis, magnified from thirty to five hundred times.

Finally, I must refer to an invention by Dr. Sigismund Theodor Stein, of Frankfort-on-the-Main, which invention will render the employment of the graphic art possible in medicine by every physician at home. I found it in the German division, under Group XIV, Scientific Instruments. There were exhibited, *a*, a photo-microscope and photo-helioscope; *b*, a photo ure-throscope; *c*, a photo-laryngoscope; *d*, a photo-ophthalmoscope; *e*, a photo-otoscope. This invention deserves the careful investigation of every practical student of medicine.

5. SURGERY AND ITS CORRELATIVE BRANCHES.—Not surgery proper but surgical technic as illustrated by surgical instruments, &c., occupied the space allotted to this division of the Exhibition. It was, also, beyond a doubt, the richest and most perfect display, in this respect, that had ever been gathered together under one roof. It would be difficult to name any useful surgical instrument ever invented which was not exhibited here in some modification or other, if not in the original itself. And what was here wanting could be found in the pavilion of military surgery, hygiene, &c.

The names of Leiter, Reiner, Thurrigel, of Vienna; Windler and Blumberg, of Berlin; Weber of Hamburg; Charrière and Matthieu, of Paris, need only to be mentioned to give the professional reader an idea of the character of this magnificent and instructive display.

The most perfect and exhaustive collection of instruments designed to illustrate laryngoscopy and laryngeal surgery, the youngest of the branches of special surgery, was presented by Professor Schrötter, of the University of Vienna. What less could be expected from the able successor of the ever-lamented Professor Tuerk?

The history of the rise and progress of laryngoscopy and laryngeal surgery is mostly confined to the invention and the perfection of instruments used in the practice of this art. This collection of Professor Schrötter had, therefore, a special interest for medical men. Hence it was the chief point of attraction of the northern Austrian gallery, where Group XIV had been placed.

The arrangement of this collection was strictly systematical. Mirrors, illuminating apparatus, guillotines, galvano-caustic instruments, &c., were each in its appropriate place. There were the original laryngeal mirrors used by Türk and Zermak in their first attempts to examine the interior of the larynx of the living man. What patience and ingenuity was there not displayed, and how impracticable and heavy they appear now!

Next to the laryngeal mirrors were placed innumerable apparatus for illuminating the larynx. Czermak, Türk, Semeleder, Tobold, Von Brüns, Mackenzie, all figured conspicuously there. Then followed apparatus for inhalation and pulverization of fluids, beginning with Sales-Giron and ending with those of Sieglé and Schmitzler. In proper order were displayed the instruments for operations within the larynx. First of all, our attention was directed to the ecraseur of Professor Von Brüns, with which, in the year 1861, he extirpated successfully from the larynx of his own brother the first polypus without the loss of blood. And what modifications and new inventions in this respect have not the last twelve years brought forth! Recall the names of Türk, Tobold, Von Brüns, Störk, Vololini, Lewin, Fauvel, Mackenzie, and what results are presented in laryngeal surgery. Vololini and Von Brüns are most brilliant in this constellation, by the additional services they rendered through the introduction of galvano-caustics into laryngeal surgery. The most subtile instruments for its application are also of their invention. Finally, Professor Schrötter exhibited additionally some very ingenious instruments of his own for operations in the trachea. But a still greater service was rendered by this celebrated laryngologist by the patience with which he daily for hours instructed the large audience of physicians and laymen constantly assembled before his collection.

From surgical instruments we turn our attention to another auxiliary branch of surgical technic, that of—

Bandages and orthopedic apparatus.—If the medical profession of the United States was noted chiefly for its absence in the previous or following sections in the department of medicine, in this division it certainly presented something original and worthy of examination.

Dr. W. F. Flührer, of Bellevue Hospital, New York, exhibited a method for the treatment of fractures as practiced at Bellevue Hospital, illustrated by twenty-three photographs. Another series of eight photographs was intended to illustrate the use of gypsum in the treatment of fractures of the thigh, also as practiced at Bellevue Hospital;

a third series of eleven photographs illustrated the use of the same agent in the treatment of compound fractures.

Accompanying these photographs was a brochure explanatory of this treatment of fractures.

Dr. Charles Fayette Taylor, of New York, exhibited a variety of orthopedic apparatus, illustrative of his method of treatment of curvatures of the spine. To this collection was attached his monograph, entitled "The Orthopedic Treatment of Pott's Disease," translated from the English of Dr. Bissenthal, Berlin, 1873. Dr. Taylor's contribution to the Exhibition was rewarded with a Medal of Progress, under Group XIV, "Surgical Instruments."

Mr. Benjamin Lee, of Philadelphia, United States, sent a number of very practical apparatus, designed for the treatment of curvatures of the spine. Their thorough workmanship and simplicity excited no little attention among those versed in this branch of surgical technic, and great was their surprise when it was found that the well-deserved claim of this firm to a prize had been ignored by the International Jury.

Manufacturers from Russia, Switzerland, Austria and Hungary, France, Germany, and Denmark, exhibited good specimens of orthopedic apparatus, that well deserved the praises which were bestowed upon them.

Dentistry must also be classed among the correlative branches of surgery. That dental science and dental technic have made greater progress in the United States of America than anywhere else, is an indisputable fact. Hence the United States department of the Vienna Exhibition presented in this respect the most complete and perfect collection as compared with the exposition in the same branch made by all the nations combined.

The American collection of dental instruments created among professionals great surprise, on account of a completeness and diversity, such as was new to dentists in Europe.

Single teeth, and complete sets of American artificial teeth, were commended for their exquisitely fine and thorough workmanship, and their material pronounced as being of the very best and finest quality that could be obtained for their manufacture.

When we are but too fully aware how much and how unjustly the American department has been assailed and sneered at, and by none more bitterly than by Americans themselves, it is especially gratifying to mention, among many very meritorious contributors, the names of Samuel White, of Philadelphia, rewarded with a Diploma of Honor (the highest distinction obtainable) for dental instruments; H. D. Justi, also of Philadelphia, a Diploma of Merit for artificial teeth, dentists' instruments, and a most convenient, elegant operating-chair for dentists; James Leslie, of Cincinnati, for crystallized gold for the use of dentists, also rewarded with a Diploma of Merit.

Dentists from nearly every country in Europe sent contributions to

this section. But America suffered nothing by the comparison. Russia, however, was peculiarly represented.

First among her contributors was a dentist of noble blood, Count Nikolai Engolitschew, and second, an artist in dentistry, Mr. Hyppolite Majinski, of Warsaw, exhibited "*Genuine American Drops for the instantaneous cure of Toothache.*" The most interesting part, however, of this announcement was, that this Russian dentist offered to cure all afflicted with toothache *free of charge* during the continuance of the Exhibition, just as he had been the Good Samaritan to the afflicted public during the Industrial Exhibition of 1870 at St. Petersburg, and at the Polytechnical Exhibition at Moscow in 1872. As an assurance of the excellence of his "American Toothache Drops," this Mr. Majinski exhibited, in addition to numerous testimonials from societies and individuals, a gold medal, a reward received from the King of Sweden. Singular coincidence! *American Toothache Drops* manufactured in *Russia* are honored with the reward of a gold medal; *American Surgery*, we are also informed, was honored by the same king with the "Order of Knighthood of Wasa." What distinction may not yet be in store for some enterprising individual as a reward for recommending Norwegian cod-liver oil as the very best manufactured and the easiest to be digested by the unfortunate patient!

English dentists were only represented by two firms, and Italy and Spain not at all. A curious collection of instruments was that of Joseph Mons, of Vienna, intended to illustrate the progress of dental technic during the last fifty years. Under the direction of the imperial royal ministry of education, Dr. Zigmondi, of Vienna, exhibited a most interesting and systematic collection of odontological preparations, of great value to the scientist, namely, a series of maxillary bones in their several stages of development and metamorphoses, from the embryo of four months to the equally toothless maxillary bone of the octogenarian.

OBSTETRICS, GYNECOLOGY, AND CARE OF INFANTS.—To this collateral branch of medical science no contributions were made from the United States. It is claimed, with how much truth this is not the place to inquire, that gynecology, at least, has reached a greater degree of development in the United States than anywhere else. Under these circumstances, it is to be regretted that our gynecologists as well as our numerous surgical-instrument makers neglected to send their products of invention as well as manufacture to Vienna, to contest fairly their claim to superiority and greater practicability in this branch than is generally granted to Europeans.

6. MATERIA MEDICA AND CHEMISTRY.—These correlative branches were classed under Group III, "Chemical Industry."

I shall pass over this section briefly, time having failed me to examine the contents of the innumerable boxes, flasks, glasses, and jars filled with pills, powders, ointments, oils, tinctures, liqueurs, essences, &c., all prepared to render suffering humanity more happy, if not

healthier, possibly sicker; a large Pandora's box filled with things clean and unclean; of the real and the unreal; a rich store of food for the scientific inquirer; a golden treasure-trove for the charlatan; where friction-matches and cod-liver oil were placed side by side with numerous specifics, such as ophthalmic waters for the blind, bitter surinam for weak stomachs, and aromatic earth and pills for the cure of the spleen. In this Group III were also included articles of food for the sick, of which Italy alone exhibited more than 800 different preparations of cocoa. Who would not envy the members of the jury that had to report upon all these! Secret remedies were excluded only from the Austrian an d German sections, yet malt-chocolate, malt-bon-bons, and Madame Rix's original "Pasta Pompadour" could not very well be excluded without creating a social revolution.

Of meritorious efforts there were also many to contrast with the former. To mention but a few:

"The pharmacopia elegans," of Parisian pharmaceutists; the collective exposition of Austria's natural mineral waters, from twenty-three springs, foremost among which figured "Carlsbad." These waters were placed together in a special pavilion.

Hungary sent specimens from twenty mineral springs. The German Empire, so rich in mineral springs, was totally absent.

France figured through the Parisian "Compagnie fermière de l'Établissement de Vichy," furnishing its natural waters, salts, and pastilles.

The Caucasus, even, sent twenty specimens from mineral springs mostly sulphurous.

Passing all those articles belonging to the materia medica of nations, as too extensive to receive consideration here, I shall only refer to two of the most remarkable collections of any one drug in this entire group. I mean the extensive collection of specimens of opium, ninety-seven in number, collected and sent by G. della Sudda, professor of the medical faculty of Constantinople. These ninety-seven different specimens were all collected in the Turkish provinces of Asia Minor. He also sent several specimens of Smyrna opium. All these were exhibited in the shape of large cakes, with a hole in the center for convenience of inspection, each sample weighing from one to two pounds.

There were also specimens of opium from Persia, the Russian Caucasus; from British India, China, Egypt, and Algiers.

The second drug I refer to is the cinchona bark, of which specimens were sent by the East India colonies of the Netherlands, the French colonies, the Philippine Islands, and Brazil. These two collections, of opium and cinchona bark, were universally admitted to be the most complete ever placed before the eye of the student.

7. Sanitary Management of the Army and Voluntary Assistance in War, but better known under the name of the Sanitary Pavilion, had found a separate home in a modest building, over which was flying a white flag with the red Geneva cross in the center.

This independent exhibition was chiefly due to the indefatigable labors of Professor Billroth, Dr. Wittelshofer, and Dr. Von Mundy. The exhibitors numbered nearly one hundred. Germany, Austria, France, Russia, Switzerland, Holland, England, North America, Spain, Sweden, Turkey, Italy, and Belgium sent valuable contributions. The entire collection was subdivided as follows:

A.—*Material for transport.*

1. Hospital railway-trains, for the transportation of the wounded.
2. Ambulance wagons.
3. Fourgons; wagons containing materials used by surgeons, medicines, provisions, &c.
4. Wagon used as kitchen.
5. Stretchers for carrying the wounded.

B.—*Surgery.*

1. Surgical instruments, apparatus, preparations, and artificial limbs.
2. Bandages, material for bandages.

C.—*Hospital service.*

1. Barracks and tents.
2. Beds and operating-tables.

D.—*Literature upon the foregoing subjects.*

Chiefly contributed by the projectors of this pavilion. Were I to enter into a consideration of each of the above sections, the labor would be so great that I might as well attempt to write the medical and surgical history of the wars of 1866 and 1870. Nor shall I call the long roll of illustrious names, of Billroth, Esmarch, Lutter, B. von Langenbeck, Wendorfer, Wilele, and many others, who, by their personal researches, experience, and fame, enriched this collection, so full of material for the professional student, and so pregnant with the reminiscences of the years 1866 and 1870–'71.

With pleasure and satisfaction we recall the model of a hospital railroad-car, which properly belonged in this sanitary pavilion, but which, for satisfactory reasons, probably, had been placed in the American division of the Exhibition, under Group XVI, Sanitary Science. This miniature hospital-car was contributed by our honored American citizen, Dr. Thomas Evans, of Paris. It was an exact representation of those hospital-cars, which, during the war of the rebellion, were constructed and used by the United States Government for the transportation of the sick and wounded of the Army. This car was provided with a special system of heating and ventilation. A Medal of Merit was awarded to Dr. Evans for his unique contribution, the only one in this group from the United States.

An honorable mention of a contribution of four volumes of hospital reports and reports of medical societies in the United States, sent by Dr. Toner, and thirty-five volumes of medical text-books sent by H. C. Lee, of Philadelphia, must be made in conclusion. We have to express our regret, when these contributions are compared with similar ones coming from nations in Europe, that the medical profession of the United States of America did so little toward a proper representation of "Medicine" at the World's Exhibition at Vienna in 1873.

F.

PHYSICAL APPARATUS AND CHEMICAL MATERIALS.

WOLCOTT GIBBS.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

PHYSICAL APPARATUS

AND

CHEMICAL MATERIALS

SUITABLE FOR

SCIENTIFIC RESEARCH.

BY

WOLCOTT GIBBS, M. D.,
RUMFORD PROFESSOR IN HARVARD UNIVERSITY.

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PHYSICAL APPARATUS AND CHEMICAL MATERIALS SUITABLE FOR SCIENTIFIC RESEARCHES.

1. INTRODUCTION.—The writer has selected as the subject of a special report on the Vienna Exhibition, "physical apparatus and chemical materials suitable for scientific researches." He was led to choose this subject partly because, on arriving at Vienna, it was found that other congenial matters had engaged the attention of his colleagues, so that the ground was, to a great extent, already occupied, and partly because he had been repeatedly applied to for information concerning apparatus by pupils and friends engaged in scientific pursuits. The Vienna Exhibition was unfortunately not particularly rich in materials for the projected report. On the contrary, it was admitted to be, from this point of view, far inferior to the French Exhibition of 1867. The writer has, therefore, endeavored to add value to this report by incorporating with it such observations as he was able to make, after his visit to the exhibition, in the workshops of Berlin, Munich, Berne, Geneva, Paris, and London, keeping also constantly in view his purpose of aiding scientific research. He has endeavored to bring this report down to the date of its presentation to the State Department by citations from the latest accessible sources of information; and in conclusion, the writer ventures to offer some advice as to the selection and importation of scientific apparatus and materials, based upon a somewhat large personal experience.

2. SUBJECTS.—For the convenience of reference the report is arranged under the following heads:

1. General physics.
2. Optics.
3. Electricity and magnetism.
4. Heat.
5. Chemical apparatus and materials.

3. GENERAL PHYSICS.—*Cathetometers.* P. Dumoulin-Froment, (Paris, Rue Notre Dame des Champs 85,) exhibited a cathetometer or instrument for the precise measure of vertical distances, having a range of one meter, and of admirable workmanship. The scales of these cathetometers are carefully compared with standards of linear measure, and the instrument exhibited appeared to leave nothing to be desired in point of accuracy. Such an instrument is indispensable in researches on the tension of vapors, in the applications of the air-thermometer, in the

study of the phenomenon of capillary action, and for various other physical purposes. The price of Froment's cathetometer is 1,000 francs.

Prof. E. Jünger, (37 Dosseringen langs Sortedamsö, Copenhagen,) exhibited a shorter cathetometer for measuring heights not exceeding half a meter. The workmanship of this instrument was also very good. Its price was 270 florins. The purchaser would, of course, require some guarantee of the accurate correspondence of its scale with the standard in the palace of the archives in Paris.

4. *Dividing-engines.*—P. Dumoulin-Froment exhibited two machines for the division of linear scales, as for instance, those of barometers, thermometers, and eudiometer tubes, and for general laboratory use; the larger machine giving hundredths of a millimeter, and of sufficient length to divide 0.^{m}60 without shifting the scale to be divided costs 1,600 francs. The smaller machine dividing about 0.^{m}30 in the same manner, costs 450 francs.

Perreaux, (L. G. Rue Jean Bart, 8,) also exhibited straight-line dividing-engines. Several of these have been imported into this country and have given great satisfaction for laboratory purposes, but where extreme precision is required we should give the preference to the engines of Dumoulin-Froment.

5. *Goniometers.*—Professor Jünger, of Copenhagen, (address given above,) exhibited a very large and well-finished goniometer of Mitscherlich's construction, with a special arrangement for centering crystals, differing from that of the original instrument, but apparently advantageous.

August Oertling, in Berlin, also exhibited a Mitscherlich goniometer, differing from the original form by the addition of a microscope for assisting in the adjustment of crystals. The writer had no opportunity of working with either of these goniometers, but, for the very small number of cases in which such instruments can be used with advantage, the instrument of Jünger appeared to deserve the preference.

6. *Areometers.*—The most reliable areometers to be purchased in Europe are probably those of Dr. H. Geissler, in Bonn, (Burgstrasse, No. 14.) The prices of some of these instruments are here given from the price-list of 1873:

(1.) Normal areometer, giving the specific gravity of a liquid directly to between the third and fourth decimal, from 0.700 to 1.850, 19 pieces in case, 24 thalers.

(2.) The same for smaller quantities of liquid, giving the specific gravities to the third decimal, 19 pieces in case, 15 thalers.

7. *Balances.*—A number of balances for chemical and physical purposes were to be seen at the Vienna Exhibition, but no one of these presented any special novelty in design, or appeared to deserve special mention. Within the last few years, however, a form of balance has been introduced by Bunge, (Paul Bunge, Hamburg-St. George, Bremerstrasse, 52,) which differs radically from the instruments in common

use, and which possesses some very decided advantages. The beams of Bunge's balances are made either of brass or of aluminum-bronze, at the option of the purchaser. They are extremely short, that of the largest balance being only 25 centimeters in length, and are also very light, a sufficient degree of strength and stiffness being given by a peculiar arrangement of braces. The rider can be moved through the whole length of the beam, but rests upon a divided slip of metal placed parallel to the beam, and with its upper edge in the plane of the three knife-edges. The supports for the pans are so adjusted that when the handle is turned through a small angle the pans are thrown into free suspension. By turning this handle alternately to the right and left, the pans are brought to rest. By turning the handles still farther the beam is also set free. Both beam and pans are gilt to prevent oxidation. The weights are of brass gilt; the smaller weights being flat coils of wire with one end sticking up to serve as a convenient handle. The dimensions and prices of these balances are given in the table.

Load of each pan ....grams..	2,000	500	200	20
Giving 1° deviation on the scale for ....milligrams..	0.2	0.1	0.1	0.02–0.01
Length of beam ....centimeters..	25	17	13	6
Width of pans ....do....	18	13	9.3	4
Price ....thalers..	130	80	60	55
Price of set of weights ....do....	25	16	12	10

Balances of this kind are now in use in the laboratory of the chemical department of Harvard University, and we have the authority of Professor Cooke for the statement that they have given great satisfaction and are to be warmly recommended.

The best French balances are probably those of Collot. (Collot frères, Boulevard d'Enfer, 28.) This maker will provide each balance, if required to do so, with knife-edges exclusively of agate, resting on agate planes. This is a great advantage in chemical laboratories, as the apartments in which the balances are kept cannot always be kept perfectly free from acid-vapors, and steel knife-edges are affected sooner or later.

8. OPTICS.—*Crystals.* Wilhelm Steeg, (Homburg vor der Höhe,) exhibited a magnificent collection of sections of crystals cut so as to show their respective optical characteristics with polarized light. The collection embraced 150 choice plates, at a cost of 500 thalers. Steeg's establishment has the highest reputation for work of this kind. The printed catalogue offers 27 species of uniaxial positive crystals cut perpendicularly to the axis; 34 species of uniaxial negative crystals; 90 species of biaxial crystals; 12 varieties of crossed crystalline plates; 11 species, cut perpendicularly to the axis or middle line, exhibiting dichroism; 19 species cubes and plates of dichroic crystals cut perpendicular or parallel to the axis or to the middle line, and set so as to be turned round to exhibit dichroism with or without the dichroscope; 13 species of dichrous crystals cut parallel to the axis for observation with

the dichroscope, and 5 species exhibiting asterism. The prices of these sections of crystals of course vary considerably according to the rarity of the species, the size and perfection of the plates, &c., but are in almost all cases moderate, while the workmanship is excellent. Steeg also furnishes Nicol's prisms and plates of tourmaline for polarization, as well as quartz prisms and lenses for spectroscopes intended for the study of the ultraviolet rays. In short all pieces of apparatus necessary for the study of the polarization of light may be found at his establishment in extraordinary perfection and at reasonable rates.

Of the less commonly known forms of apparatus, we may mention the large instrument for polarization devised by Groth, and intended for the study of the optical phenomena of crystals. The apparatus includes stauroscope, goniometer, oil-vessels, and heating apparatus, is extremely well made, and furnished at the price of 160 to 180 thalers.

9. *Polaristrobometer.*—Hermann & Pfister, in Berne, manufacture Wild's polaristrobometers in two sizes. The smaller and cheaper instrument costs 185 francs, but has little or no value as an instrument for research. The larger apparatus costs 385 francs, is admirably made, and has been greatly improved by the substitution of Iceland spar for the quartz disks of the earlier forms. This instrument is now generally preferred to the other forms of polarizing apparatus employed in the estimation of sugar and in the determination of the rotatory powers of liquids generally.

10. *Spectroscopes.*—No important improvements have recently been made in spectroscopes of the older form with one or more prisms. We should give the preference for instruments of this construction to Steinheil or to Merz, in Munich; but the writer saw in Europe no spectroscopes to compare with the large apparatus constructed for the Institute of Technology in Boston, by Alvan Clark & Sons, of Cambridgeport. The best direct vision spectroscopes are those of Hofmann, in Paris.

Hermann & Pfister, in Berne, construct to order a large spectrometer possessing some advantages of form. A somewhat similar instrument may be obtained from the Société Génévoise, Plain Palais, Geneva. We should give, however, for this instrument, the preference to Brunner, in Paris. (Address Brunner, Paris, Rue de Vaugirard, 59.) Brunner constructs a larger and a smaller spectrometer. The larger instrument costs, with micrometer eye-piece, about 1,500 francs. It reads with two verniers to five seconds of arc. The smaller instrument reads to ten seconds with verniers, and costs 550 francs. The workmanship is extremely good, and the reputation of the establishment in Europe very high. One of the large instruments has been ordered for Harvard University.

11. *Microscopes.*—The great English microscope-makers, Ross, Powel & Lealand, and Beck, were not represented at all at the Vienna Exhibition, and the display of microscopes was particularly meager. Hartnack, whose instruments are well known in this country, is now at Potsdam,

in Prussia. Nachet, also well known among us, is at No. 17 Rue St. Severin, Paris. The work of all these makers is too well known here to require any special notice. On the other hand, the instruments of Zeiss, a more recent maker, deserve special notice for their extraordinary cheapness and their equally remarkable excellence. (Carl Zeiss, Jena, Prussia.) The following is a list of prices of Zeiss's objectives, taken from his most recent price-list:

Number.	Systems.	Angular aperture.	Equivalent focus.	Magnifying power, length of tube 155 millimeters for a visual distance of 250 millimeters with the eye-piece.					Prices in marks.
				1.	2.	3.	4.	5.	
		Degrees.	*Millimeters*						
	DRY-SYSTEM.								
1	*a*	....	30, 45, 60	5 to 20	....	....	....	....	12
2	*a a*	20	32	18	25	40	50	70	27
3	A	20	16	45	60	85	110	150	24
4	A A	33							30
5	B	40	10	70	95	125	160	220	30
6	B B	60							42
7	C	48	6.4	110	140	200	260	350	36
8	C C	90							48
9	D	72	4.2	180	220	300	400	550	42
10	D D	100							54
11	E	105	2.8	240	330	450	600	840	66
12	F	105	1.8	380	500	720	950	1,400	84
	IMMERSION.								
13	No. 1	180	3.0	220	300	420	560	790	90
14	No. 2	180	1.7	400	530	760	1,020	1,500	144
15	No. 3	180	1	680	900	1,300	1,700	2,300	270
	Oculars			1	2	3	4	5	
	Equivalent focus, millimeters			52	45	33	25	18	

12. ELECTRICITY AND MAGNETISM.—*Telegraphs, &c.*—The Brothers Siemens, of Berlin, made a very fine display of telegraphic apparatus of all kinds. The only instrument, however, coming within the scope of this report was a galvanometer, with a heavy steel needle shaped like a tuning-fork, an appropriate damper of solid copper, and two movable and replaceable coils of wire. The needle was provided with a mirror, and the angular deviations were read off with a telescope and scale. The writer had an opportunity of seeing the extremely satisfactory performance of this instrument, the peculiar steadiness of motion being especially worthy of notice. The apparatus was, however, somewhat expensive, and, though well adapted for research, is not likely to replace the much cheaper instruments of Sir William Thompson, as made by Elliott Brothers, of London.

Though the instruments of the last-named firm have already a reputation in this country, some information as to special forms and prices may be of value. (Elliott Brothers, 449 Strand, London.)

	£	*s.*	*d.*
Tangent galvanometer, on Gaugain's construction, with four coils and two needles	6	10	0
Reflecting galvanometer, on Sir William Thompson's principle, with astatic needles, tripod pattern, short, thick wire, with lamp-stand and scale	10	10	0

	£	s.	d.
The same, with 2,500 ohms resistance	12	12	0
Thompson's reflecting artatic galvanometer, with four coils, upward of 5,000 ohms resistance, with lamp-stand and scale	18	18	0
The same, differential	21	10	0
Set of shunts $\frac{1}{9}$, $\frac{1}{99}$, $\frac{1}{999}$, the resistance of the galvanometer	3	10	0
Copy of B. A., unit or ohm	2	10	0
Set of resistance-coils, 16 bobbins, 10,000 ohms in the aggregate, with a Wheatstone's bridge attached, and three pair of equal resistances, two tens, two hundreds, and two thousands in German-silver wire	36	0	0
Large set of resistance-coils, in German silver wire, extra thick, dial pattern, arranged in units, tens, hundreds, and thousands with bridge and four pair of proportional coils	48	0	0
Set of resistance-coils, 100,000 ohms in four coils, platinum-silver alloy wire	12	0	0
Wheatstone's bridge, with divided meter	3	10	0
Poggendorff's rheochord	2	10	0
Quadrant electrometer, on Thompson's principle for lectures, which will show the tension of a single cell	4	0	0

I believe I can safely assert that no other firm in Europe offers so large and so well-constructed an assortment of apparatus for electrical measurements.

Thompson's electrometer in the most complete and perfect form is furnished by James White, of Glasgow, (78 Union street,) at the price of £30.

The same instrument of much simpler construction, arranged by Kirchhoff, to be read with a lamp and scale, may be obtained from Desaga, (C. Desaga, Universitäts-Mechanicus, Heidelberg, Baden, Germany,) at the very moderate price of 90 florins.

13. *Inductoriums.*—These instruments, more commonly known in this country as Ruhmkorff coils, are manufactured in all the large European cities, and are sold at very low rates. Those made by Alfred Apps, (433 West Strand,) in London, deserve attention from their cheapness and excellent performance.

Apps's price-list is as follows:

	£	s.
$\frac{3}{4}$-inch spark in air with 1-pint cell	4	4
$1\frac{1}{2}$-inch spark in air with 1-pint cell	6	6
2-inch spark in air with 2-pint cell	8	8
3-inch spark in air with 3-pint cell	10	10
4-inch spark in air with 4-pint cell	14	14
6-inch spark in air with 5-quart cell	21	0

	£	s.
8-inch spark in air with 5-quart cell	26	5
10-inch spark in air with 5-quart cell	36	15
15-inch spark in air with 6-quart cell	63	0
24-inch spark in air with 6-half-gallon cell	105	0
36-inch spark in air with 8-half-gallon cell	250	0
48-inch spark in air with 8-half-gallon cell	350	0
60-inch spark in air with 8-half-gallon cell	500	0

Larger sizes to order.

14. *Holtz electrical machines* with revolving plates of ebonite or hard rubber instead of glass may be obtained from J. C. Schlosser, Mechaniker, Königsberg, Prussia. These machines are greatly to be preferred to those with glass disks, on account of the brittleness of glass and the danger to which large and thin disks are exposed.

15. *Magnetic apparatus.*—Meyerstein, in Göttingen, (Dr. M. Meyerstein, Göttingen, Hanover,) constructs to order the apparatus of Gauss and Weber for the determination of the constants of terrestrial magnetism, both in fixed observatories and for magnetic surveys. His price-catalogue includes the following lists, of which the first contains the special apparatus of Gauss and the second that of Weber:

		Thalers.
(18.)	First. Magnetic apparatus for the determination of the absolute declination and intensity of the horizontal component of the earth's magnetism, including the subsidiary apparatus; length of the magnetic needle, 2 feet; weight, 4 pounds	160
(19.)	Magnetic apparatus for observations of the variations of declination, dimensions as in No. 18	50
(20.)	Magnetic apparatus like No. 18; weight of the magnetic needle, 2 pounds; length, 1 foot; subsidiary apparatus included	95
(22)	Bifilar magnetometer for variations in the intensity of the horizontal component of the earth's magnetism; weight of the vibrating-rod, about 25 pounds; length, about 4 feet	100
(23.)	A damper for this apparatus	40
(24.)	Bifilar magnetometer for a bar 2 feet in length and weighing 4 pounds	76
(25.)	Simplest form of the same	40
(32.)	Second. Apparatus of Weber for variations of inclination or dip	56
(33.)	Apparatus to determine the vertical component of the earth's magnetism, consisting of a bar 2 feet in length, which carries in the middle two plane-mirrors	45
(34.)	Induction-dipping needle with needle-reading	60

		Thalers.
(36.)	Earth-inductor, according to size and quantity of wire	140 to 500
(57.)	A galvanometer for this inductor	100
(28.)	A smaller earth-inductor, with a corresponding galvanometer, reading-telescope, scale, and scale-holder. This instrument is specially contrived to determine the dip on journeys	180
(39.)	An electro-dynamometer, according to order, with a movable mirror, which can be adjusted for any azimuth....	
(40.)	A galvanometer, the magnet of which consists of a steel ring, with a plane-mirror set in. The multiplier is circular, and surrounded by a powerful damper. According to fineness of wire	50–60

In addition, Meyerstein constructs the following:

(26.)	Large magnetometer of the most recent construction, not only to determine the absolute intensity and absolute declination of the horizontal component of the earth's magnetism, but also to determine the dip, with the assistance of Weber's earth-inductor	266
(27.)	Magnetic apparatus specially adapted to observations upon journeys, giving variations in declination, absolute declination, and horizontal intensity. Length of the magnet, 150 millimeters	150
(28.)	Magnetic apparatus, like No. 27; length of magnet, 100 millimeters. These forms of apparatus, as well as all the larger magnetometers, are arranged for the reception of a multiplier	120
(29.)	Compass to determine the absolute intensity, with box and suspension to determine the time of vibration of the deflecting-bar	25
(30.)	Small magnetic apparatus, wiih four deflecting-magnets. The divisions of the compass are upon a mirror, so that parallax may be avoided in reading	30
(31.)	Dipping-needle, in which the circle does not surround the needle, but is placed at some distance from it. The circle carries a vernier, to which two micrometer-microscopes are fastened, by means of which the position of the needle is observed. With this instrument will be found four needles of 240 millimeters in length, two magnetizing-bars, a trough to hold the needle to be magnetized, a pair of pincers to place the needle in the trough, and a declination-needle with suspension. The instrument has also an arrangement to reverse the needle without opening the box	280

Dr. Th. Edelmann, in Munich, also constructs magnetic apparatus for use upon journeys. (Th. Edelmann, am Polytechnicum, München, Bavaria.) These instruments are constructed with small magnetic bars, in general accordance with the principles laid down by Lamont.

The prices are as follows:

	Marks.
Edelmann's magnetometer, for the determination of the declination and horizontal and vertical intensity	250
Edelmann's magnetometer, with constant angles of deflection. The reading in experiments on deflection is effected by the coincidence of images in mirrors making a definite invariable angle with each other. The distance of the deflecting-bar is variable and read off on a scale. The apparatus is portable, for travelers' use	210
Lamont's portable theodolite, modified by Jehlinek	800
Edelmann's dynamometer for absolute measures. The apparatus serves to determine the earth's magnetic intensity in absolute measure, by means of galvanic currents, and also as a galvanometer	400

16. *Magnets.*—The steel magnets manufactured some years ago by Lozeman, of Haarlem, in Holland, attracted much attention on account of their extraordinary power. At the Vienna Exhibition the "Socialität von künstlichen Stahl-magneten" of Haarlem exhibited, besides a very large magnet with five steel plates, smaller magnets, weighing about 1 kilogram, and lifting 36 kilograms. This is about equal to the performance of Logeman's magnets. The same association exhibited a magneto-electric machine on Siemens's plan, with five pairs of flat single-plate magnets. Such an instrument would doubtless possess great power for its size and weight, but magneto-electric machines with permanent magnets have lost their interest and value to a great extent since the introduction of dynamo-electrical machines, and especially since the recent improvements of Gramme, von Hefner-Alteneck, Farmer, and others.

17. HEAT.—Very little apparatus intended for the study of heat was exhibited at Vienna. I have, therefore, drawn as much as possible upon other sources of information.

Air-thermometers.—Gosse (Rue Paradis Poissonière 22, Paris) exhib- rmometers of porcelain of two different forms, a larger with spherical and a smaller with cylindrical air-chambers. These instruments are well known to physicists, and serve to measure temperatures up to those at which the porcelain begins to soften.

18. *Mercurial thermometers.*—Dr. H. Geissler (Bonn, Prussia, Burgstrasse, 14) manufactures thermometers of various kinds, which are highly esteemed in Germany. The following list is taken from his price-catalogue:

	Thaler.
Standard thermometers, with milk-glass scale, from 0° to 100°, reading to $\frac{1}{10}$ of a degree	10
Standard thermometers, with milk-glass scale, from 0° to 50°, reading to $\frac{1}{10}$ of a degree	6
Fine standard thermometers, from 10 to 10°, reading to $\frac{1}{50}$ of a degree, each	7
Thermometers for chemical purposes, giving single degrees, from 0° to 360°	3.5
Thermometers for chemical purposes, giving single degrees, from 0° to 200°	2.5
Thermometers for chemical purposes, giving single degrees, from 0° to 100°	1.10
Fine thermometers, graduated on the stems, 0°—360°	2.20
Fine thermometers, graduated on the stems, 0°—250°	2.10
Geo-thermometers of Walferdin, for ascertaining the temperatures of borings in artesian wells, giving tenths of a degree	8

Thermometers of extreme delicacy are also constructed by Baudin, in Paris, but I am unable to give either his address or list of prices. He constructs thermometers only to order, and his prices vary from twenty to fifty francs. Fastré, whose reputation was very high a few years ago, no longer manufactures. Regnault's apparatus for the study of the laws of heat can be obtained in great perfection from L. Golaz, Rue de vielle, Estrapade, Paris.

19. CHEMICAL MATERIALS.—*Alcohols.*—Kahlbaum, in Berlin, (C. A F. Kahlbaum, Schlesische Strasse, Nos. 13 and 14, Berlin,) exhibited a fine collection of alcohols and alcoholic preparations. This establishment is regarded in Germany as the best source of this important class of chemical materials, and I have accordingly selected from his price-list (April, 1875) such articles as are of most general use for purposes of research:

20. *Methyl series.*—

		Mark.	Pfenning.
Methylic bromide	100 grams	15	0
Methylic iodide	do	48	0
Methylic alcohol	kilogram	4	50
Baric methyl-sulphate	do	24	0
Potassic methyl	do	21	0
Formic acid (1.22)	do	30	0
Sodic formate	do	30	0
Sodic nitro-prusside	100 grams	11	0
Zinc methyl	do	36	0

21. *Ethyl series.*—

Ethylic bromide	kilogram	24	0
Ethylic iodide	do	45	0

		Mark.	Pfenning.
Ethylen chloride	kilogram..	36	0
Ethylen bromide	do....	35	0
Ethylidene chloride (commercial)	do....	30	0
Baric sulphovinate	do....	12	0
Potassic sulphovinate	do....	8	0
Aldehyd ammonia	do....	30	0
Zinc ethyl	do ...	27	0

22. *Propyl series.*—

Propylic bromide	do....	18	0
Propylic iodide	do.....	18	0
Isopropylic iodide	do ...	18	0
Propylic alcohol	do....	60	0
Isopropylic alcohol	100 grams..	20	0
Aceton (pure)	kilogram..	40	0
Propionic acid	100 grams..	24	0
Allyl bromide	do....	15	0
Allyl iodide	do ...	15	0
Allyl alcohol	do....	8	0

23. *Butyl series.*—

Isobutyl bromide	do....	4	50
Isobutyl iodide	do....	12	0
Isobutyl alcohol	kilogram..	6	0
Baric isobutyl-sulphate	do....	15	0
Potassic isobutyl-sulphate	do....	15	0
Isobutyric acid	do....	60	0
Normal butyric-acid	do....	55	0
Crotonic chloral	100 grams..	15	0

24. *Amyl series.*—

Amylic bromide	kilogram..	36	0
Amylic iodide	do....	60	0
Baric amyl-sulphate	do....	8	0

25. *Hexyl series.*—

Hexyl iodide	100 grams..	30	0
Capronic acid	do....	20	0
Capronic acid (of fermentation)	do....	5	20
Caprylic alcohol	do....	6	0
Caprylic acid	do....	20	0

26. *Aromatic series.*—

Benzol (crystallizable)	kilogram..	4	80
Benzol monobromide	do....	45	0
Resorcin	10 grams..	10	50

		Mark.	Pfenning.
Dimethyl-anilin	kilogram	24	0
Diphenyl-amin	do	12	0
Toluol	do	7	50
Toluol bromide (liquid)	100 grams	4	50
Toluol bromide (solid)	do	6	0
Benzyl bromide	kilogram	50	0
Kresol	100 grams	24	0
Orcin	do	45	0
Toluidin (liquid)	kilogram	24	0
Toluidin (solid)	do	30	0
Phthelic acid	100 grams	18	0
Naphthalin	kilogram	3	0
Nitro-naphthalin	do	15	0
Naphthylamin	do	18	0
Anthracene	do	18	0
Iodide of phosphonium ($PH._4 I.$)	do	18	0

Dr. Theodor Schuchardt, in Görlitz, (Prussian Silesia,) exhibited a very large and fine collection of chemical preparations, many of great rarity. I extract from his most recent price-list the names and prices of a few substances:

		Thaler.	Sgr.
Cæsium alum	1 gram	0	20
Cæsium chloride	do	3	13
Rubidium alum	10 grams	0	12
Rubidium chloride	do	2	10
Tellurium	do	6	0
Selenium	do	1	4
Yttrium sulphate (crystallized)	1 gram	0	15
Erbium sulphate (crystallized)	do	0	12½
Lanthanum sulphate (crystallized)	do	0	23
Didymium sulphate (crystallized)	do	0	9
Vanadium terchloride	10 grams	3	0
Molybdic acid	½ kilogram	5	0
Molybdic acid (sublimate)	do	10	0
Tungstic acid (pure)	do	3	10
Silicon (crystallized)	1 gram	1	10
Boron (crystallized)	do	4	17
Glucina sulphate (crystallized)	10 grams	1	0
Indium (metal)	1 gram	4	20
Sodium (metal)	½ kilogram	3	12
Potassium (metal)	do	32	0
Magnesium (metal in bars)	10 grams	1	8
Palladium (foil and wire)	1 gram	1	16
Thallium (metal)	10 grams	2	8
Thallium (sulphate)	do	2	25
Aluminum (bars)	½ kilogram	19	0

These prices will, on the whole, compare favorably with those of other dealers. Thallium may sometimes be had at a very reasonable rate through the friendly intervention of Dr. R. Boettger, Frankfurt am Main.

Many of the rarer metals and metallic salts may be procured with advantage from Johnson, Matthey & Company, (Hatton Garden, London.) The following memoranda are taken from their most recent price-list:

Palladium (ingot or wire)	per ounce troy..	£6 6*s.*
Iridium (pure melted)	do....	3 12
Osmium (sponge)	do....	3 12
Rhodium (pure melted)	do....	6 6
Rhodium sodio-chloride	per ounce avoirdupois..	3 15
Ruthenium	per ounce troy..	50 0
Aluminum (ingot)	per ounce avoirdupois..	5*s.* 6*d.* to 7*s.*
Aluminum (sheet and wire)	do....	6*s.* 6*d.* to 7*s.* 6*d.*
Magnesium, (distilled,) wire and ribbon	do....	10*s.* to 11*s.*
Magnesium, (distilled,) broadband and rod	do....	7*s.* 6*d.* to 8*s.* 6*d.*
Magnesium, (distilled,) plates and powder	do....	7*s.* 6*d.* to 8*s.* 6*d.*
Selenium (rods)	per ounce avoirdupois..	60*s.*
Silicon (crystals)	do....	100*s.*
Chromium (metallic)	do....	160*s.*
Potassium (metallic)	per pound avoirdupois..	80*s.*
Sodium (metallic)	do....	8*s.* 6*d.*
Sodium (pure hydrate)	do....	15*s.*

Materials for chemical researches may be obtained at reasonable prices from the following dealers:

Dr. H. Trommsdorff, Erfurt.

Dr. Theodore Schuchardt, Görlitz, Prussian Silesia.

Dr. L. C. Marquart, Bonn on the Rhine.

Chemische Fabrick auf Actien, (vormals E. Schering,) Berlin, Fenn Str., 4.

E. Merck, Darmstadt.

The preparations sold by these firms are, however, in all cases to be looked upon as raw material, more or less pure. Really pure chemicals are not to be purchased of any dealer in any country. All, or nearly all, the dealers will send their price-lists if direct application be made to them, and as these price-lists are issued from time to time—often at regular intervals—they are very convenient for consultation and reference.

27. *Engines for laboratories.*—In large laboratories it is desirable to have an easily-managed and safe motive-power which can be applied to a variety of useful purposes. Small and safe gas-engines are now made in Paris (Comp. du Gaz Quai Gemmapes No. 84) at the following prices: ¼ horse-power, 1,500 francs; ½ horse-power, 1,900 francs; 1 horse-power, 2,500 francs. The engine is upright and more compact than that of Lenoir. It is very highly spoken of.

28. CHEMICAL GLASSWARE.—Chemical glassware may be had from a large number of dealers, but the true Bohemian hard-glass, free from soda and from lead, though always professedly kept in stock, is difficult to obtain. For this glass recourse may be had with confidence to Josef Kawalier: Sazawa bei Kolin, Bohemia.

In sending out for combustion-tubes the size of the tube and thickness of the glass should be carefully stated.

Graduated glass-tubes for the measurement of gases, and graduated vessels of all kinds, may be obtained in Germany from Dr. H. Geissler, in Bonn, or in Paris from Alvergniat Frères, No. 10 Rue de la Sorbonne.

29. *Conclusion.*—In concluding this report the writer ventures to add some advice on the importation of scientific apparatus which, it is hoped, will be of service, and which is based upon a long experience. Colleges are now authorized by law to import scientific apparatus free of duty. It will be found in all cases advantageous to import directly from the maker. Agents of all kinds charge commissions which add materially to the cost of importation. It is well before importing, if the funds on hand are not large, to write directly to the instrument-maker and obtain his latest price-list. The prices given above will serve as most useful guides, but the cost of manufacture, even in Germany, has increased very much of late years, and continues to increase. In general, it is safe to estimate the total cost of importation at one-half more than the price of the apparatus in Europe. Payment of small sums is now very conveniently made by means of postal orders, which can be obtained on most European countries. Larger sums may be paid by bills of exchange. All instruments and apparatus should be forwarded as freight, and not by express, and addressed to the person sending the order. The agents of the steamship companies will, if desired to do so, notify the consignee by telegraph on the arrival of the apparatus in port. The services of a reliable custom-house broker should be engaged beforehand, and he will promptly forward the papers to be duly executed, and will take the entire charge of forwarding the apparatus to its destination. When the parties importing are known, personally or by reputation, to the collector, permission may usually be obtained to have the apparatus passed without opening the cases. When this cannot be done, the case should be opened in presence of some person representing the importing college, if the apparatus is of delicate construction, as custom-house handling is usually extremely rough, and the instrument-maker can only be held responsible for damage done through negligence in packing. In all cases it will be found advisable to have the apparatus sent to the ports of Boston, Philadelphia, Baltimore, or New Orleans, in preference to that of New York, the press of business being much less, and the care in handling consequently greater.

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G.

INSTRUMENTS OF PRECISION.

C. F. CARPENTER.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

INSTRUMENTS OF PRECISION.

BY

CHARLES F. CARPENTER, M. D.,
HONORARY COMMISSIONER OF THE UNITED STATES.

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INTRODUCTION.

(EXTENT AND CHARACTER OF EXHIBIT; STRIKES; LABOR-SAVING MACHINERY.

1. In this group, Germany, Austria, Switzerland, England, and France were foremost in their displays. The English department was surprisingly deficient, except in marine chronometers and watches; and even in this class, some of the most celebrated manufacturers were not represented. In the French department, there was also a notable neglect to make any display on the part of establishments well known for the superior construction and finish and the moderate price of their instruments. Switzerland was very creditably represented; of her 1,071 exhibitors, 80 were in this group. This country, and some parts of Germany, appear to excel all others in combining cheapness with exceedingly fine workmanship, showing upon their productions the result of educating the minds of their skillful artisans.

2. In some parts of Germany, the bad effect of strikes among the workmen is beginning to show itself. An advance of 25 per cent., claimed in some sections, will, if they succeed, certainly prevent many of their productions coming to this country, as, with the present import-duties, our artisans can successfully compete with them, both in quality and price.

Germany, France, and Switzerland are gradually adopting labor-saving machines. Their most intelligent managers are fully aware that such a course must be taken in order to maintain themselves in the manufacturing world.

The wonderful advance made in watch-making in this country is one of the remarkable instances in which an entirely new industry has been taken up, an immense product put upon the market, and a national reputation established in about twenty years, competing successfully with countries that have been engaged in it since its infancy, aided by exceedingly low prices of labor. To sustain the position we now hold, apart from further progress, will require the utmost energy and skill we have at our command.

CHAPTER I.

CHRONOMETERS AND WATCHES.

HISTORICAL; HARRISON'S CHRONOMETER; DR. HOOKE'S WORK; ISOCHRONISM; ACCURACY; GREENWICH OBSERVATORY RECORDS; BRITISH EXHIBITS; POCKET-CHRONOMETERS AND WATCHES; COMPENSATION; SWISS AND ENGLISH WATCHES; VALUE OF THE BALANCE-SPRING; AMERICAN MARKET; SCHOOLS OF HOROLOGY; TOURBILLON ESCAPEMENT; VARIOUS EXHIBITS; TESTS OF WATCHES; AWARDS; BREGUET ON CHEAP WATCHES; COMPARATIVE MERITS OF EXHIBITS; IMPROVEMENTS.

3. MARINE CHRONOMETERS.—The great increase of navigation in the sixteenth century established the fact that the one great want of the mariner was the means of ascertaining the position in longitude of his vessel when at sea. The urgent need of some such instrument, and the belief that its construction was possible, induced the governments of Spain, France, and Holland to offer, during the whole of the seventeenth century, rich rewards in order to stimulate the zeal and to quicken the inventive faculties of their philosophers and mechanicians. In 1714, the Parliament of England offered the substantial reward of £20,000 to any inventor of an instrument which would, under all circumstances in which it was likely to be placed, keep time with such accuracy as to determine the longitude of a place within the distance of half a degree, or thirty geographical miles. These rich rewards, and the hope of making discoveries that would give them fame and honor, induced the most skillful mechanicians of Europe to give their attention to the invention of the desired instrument. In 1761, John Harrison constructed a chronometer, of which the rate varied so little that, on being sent to Port Royal, in Jamaica, it proved, on the eighty-first day of the voyage, that the captain was wrong in his reckoning, by the usual method, a distance of ninety miles; the chronometer's error was less than eighteen miles. Harrison was adjudged to have complied with all the conditions required by the act of Parliament, and received the full reward of £20,000.

4. Comparatively few persons are aware of the vast amount of mechanical skill and mental labor it has demanded, through a course of two centuries, to bring to its present state of perfection this the most perfect piece of mechanism known to man. Produced as it has been, after many failures and disappointments, at an infinite cost of time, money, labor, and perseverance, and finally executed in such harmonious consistency with certain known laws as to be able to indicate to the lonely mariner, by day or night, in storm or in calm, in heat or cold, almost the very spot on which his ship floats on the vast expanse of the trackless ocean, its marvelous precision and perfection may well be

regarded as one of the greatest boons ever secured to his race by the ingenuity of man, and as one of the proudest triumphs of human reason.

Down to the middle of the seventeenth century, horology could only be considered as a mechanical art, depending entirely upon good workmanship for its excellence; but, at that period, Dr. Hooke raised it to the rank of a science by propounding its laws, and enriching it with those valuable discoveries and inventions which rendered skillful manipulation a mere accessory, although an indispensable one, to carrying out the governing laws and principles which he had deduced from the highest branches of science. Only those who have studied the science and history of horology, and have been practically engaged in it, can form a correct idea of the difficulties that had to be overcome to secure the present state of perfection of instruments for keeping time.

5. It was discovered that the effect produced by changes in temperature was one great difficulty to overcome. In 1773, Berthoud established with certainty, by calculation and experiment, that one of his marine watches varied to so great an extent as 6 minutes and 33 seconds in passing from 32° to 92° Fahrenheit, while a clock with a seconds-pendulum was known not to vary more than about twenty seconds under similar circumstances.

The amounts in loss of time due to three causes operating conjointly were as follows:

	Seconds.
Loss per diem by expansion of diameter of balance	62
Loss per diem by loss of spring's elastic force..................	312
Loss per diem by elongation of spring	19
	393

or 6 minutes 33 seconds.

The discovery and application of the laws of isochronism in the balance-spring by Dr. Hooke and Mr. Arnold in England, and Leroy and Berthoud in France, imparted the most essential quality for keeping a regular rate of time to the chronometer; particularly was this so when the temperature-error, as above, was known.

Isochronism is an inherent property of the balance-spring, depending entirely upon the ratio of the spring's tension, following the proportion of the arcs of inflexion. A balance-spring, therefore, of any force whatever, having the progression required by the law of isochronism, will preserve this quality, whether it be applied to a balance making rapid or slow vibrations.

6. The great advantage of an isochronal spring is its innate power of resisting the influences which cause a change of rate, such as change of position, increased friction as the works become dirty, or the viscidity of the oil at low temperatures.

Indeed, it is surprising to see chronometers return from sea with scarcely a change of rate, although some of them have been going for

three or four years, and even for longer periods of time, and the vibrations of the balance had fallen off to a very small arc in consequence of the oil becoming so viscid that, in some instances, a slight degree of force has been required to draw the pivot out of the fourth wheel-hole. But what was still more remarkable, some of these chronometers, after being cleaned, have been observed to take up their original rate, even perhaps with a threefold amount of vibration. The mechanical execution of the different parts of a chronometer could be done in as finished a manner a century ago as at the present time, yet they had very different time-keeping qualities.

7. After the principles of adjustment for temperature and isochronism were known, the skillful application of them has gradually improved the time-rate.

By looking at the best rates obtained at the Greenwich Observatory during the years mentioned below, it may be seen what progress has been made in the performance of chronometers from the year 1800 to the present time.

Up to 1835, nothing had been used superior to the compound balance as constructed by Ernshaw; but it was then discovered that this compensation-balance had a regular error, in extremes amounting to several seconds, and from that time until 1873 nothing but balances with auxiliary compensation could stand any chance at the Greenwich trials, owing to the trials being not far from twice as severe in temperature as at the beginning of this century. Formerly, the chronometers were not tried in heat, but in severe cold and middle temperature; they are now tried in heat, such as is experienced at the tropics, and such cold as it is probable they will be subjected to in winter. This in itself is enough to double the error of the ordinary compensation-balance.

The trial-numbers are made up at Greenwich by taking the differences between the highest and least rate, added to the greatest change of weekly rate multiplied by two; and those giving the best results are purchased by the admiralty for government use.

The best trial, in 1800, was: temperature, 46° to 71° Fahrenheit; greatest difference from week to week, 5.2 seconds; trial-number, 20 seconds.

Temperature, not given, 1840; greatest difference from week to week, 4.3 seconds; trial-number, 20 seconds.

Temperature, 33° to 96° Fahrenheit, 1870; greatest difference from week to week, 3.8 seconds; trial-number, 13.1 seconds.

Temperature, 35° to 96° Fahrenheit, 1873; greatest difference from week to week, 3 seconds; trial-number, 11.1 seconds.

If the last four years' rate of improvement should continue, we will soon arrive at a point where we will have to remain stationary, because the nearer we approach perfection the greater will be the difficulty in overcoming the remaining errors.

8. W. Weichert, Cardiff, Wales, exhibited two very fine chronom-

eters, one with a thermometer and barometer attached to it. By the superior performance of his chronometer No. 2300 at the Greenwich Observatory trials in 1873, it was placed first in order of merit. The duration of the trial was thirty weeks; the lowest temperature it was subjected to was 35°, and the highest 96° Fahrenheit; trial-number, 11.1; greatest difference between one week and the next, 3 seconds. This chronometer had Kullberg's flat-rim balance without auxiliary compensation, and is the first instance since the invention of chronometers in which any balance has given such results.

The most extensive display of marine chronometers was made by V. Kullberg, of London. They were certainly beautiful specimens of horological art, comprising in their construction all of the most approved principles known at the present time.

His chronometer No. 1799, flat-rim balance, without auxiliary compensation, gave the best results in 1872 at the Royal Observatory, Greenwich, in competition with chronometers made by thirty-seven other makers. The duration of the trial of each chronometer was twenty-nine weeks; the lowest temperature to which they were subjected was 40° Fahrenheit, and the highest 95° Fahrenheit.

C. J. Klaftenberger and J. R. Lozada, of London, and Sivel & Walter, of Cork, also had on exhibition finely-executed marine chronometers.

9. Mr. Breguet, A. H. Rodanet & Co., T. Leroy, and Leroy & Sons, of Paris, were the only French makers who made any display. Their chronometers appeared to be well made; but they did not exhibit any remarkable qualities to distinguish them particularly from other makers.

Each chronometer should have had attached to it a certificate from an observatory, giving in detail its variations during a trial of many weeks, which would have shown any points of superior excellence that it might have possessed.

Grandjean, Heinrich & Co., of Locle, Switzerland, Kiek & Casseres and A. Hohwii, of Amsterdam, M. Peterson, of Altoona, W. Brocking, of Hamburg, and M. Domenico, of Leghorn, Italy, exhibited well-made chronometers, but none of them showing any new features worthy of particular mention.

An electro-magnetic chronometer, by Josef Danischewsky, Wilna, chronometer-maker to the Russian navy, was an ingenious piece of work, and was arranged as a controlling time-piece; communication being made and broken with an electrical clock at every full vibration of the balance. It was the only one of its kind in the exposition, and for some purposes, might be a very valuable instrument. Chronometers as made in our own country will compare favorably, both in plan of construction and excellence in finish, with any made in Europe. In fact, the work produced by some of our makers cannot be excelled anywhere in mechanical perfection of form and finish; but none were sent to the exposition.

10. POCKET-CHRONOMETERS AND WATCHES.—In this department, the

display from Switzerland surpassed all other nations, it being one of the most important industries of that isolated little republic. The mechanical excellence shown in their finest watches is certainly bordering on perfection, and their cheapness will enable them to be sold in all the markets of the world.

There are observatories in Geneva and Neuchatel, where their first-class watches are put upon trial for many weeks; and they certainly have produced watches keeping time with marvelous accuracy, as shown by the certificates accompanying them, signed by the officials at the observatories. The finish that can be given to the different parts of a watch is all that can be desired. Superior excellence can only be obtained through the simplest and most economical arrangement of the proportions and positions of the different parts, then adjusting the balance for heat and cold and position, and the hair-spring for isochronism.

11. The proper arrangement of the weights, or small screws, in the rim of a compound balance counteracts the effects that are produced upon the hair-spring by an increase of temperature.

This spring being several inches in length is affected by a slight increase of heat, making the watch run slow; this error is counteracted by the movable ends of the rim of a compound balance, which, as the heat increases, move toward the center of the balance, thus making a portion of it smaller in circumference, which causes the watch to run faster. But the practical application of this principle has not yet been brought to perfection, as, at a medium temperature, the adjustment might be all that could be wished for, yet, at extremes, 32° and 98°, there will be errors that cannot yet be overcome, but they are gradually being reduced by the skill of the most ingenious and scientific horologists.

When a watch is hanging by its pendant, the friction upon the pivots of the balance-staff is greater than when it is lying upon one of its sides. In a hanging position, the friction is upon the *sides* of the pivots; in lying down, it is upon the *end* of one of the pivots. This difference in the amount of friction makes a difference in the length of the arc of vibration of the balance.

In time, thickening of the oil and dirt will lessen the power of the train upon the balance, and consequently cause it to vibrate in smaller arcs. Any decrease of power in the mainspring will also produce the same effect. This difference in the length of the arcs of vibration of the balance will cause the watch to run fast or slow, unless the error is counteracted by giving the hair-spring a certain invisible property called isochronism; that is, giving it a certain tension that will cause the small and large arcs of vibration of the balance to be performed in the same length of time. This condition of the hair-spring is brought about by giving it a certain length, and in some springs by giving the outer coil a certain curve. These adjustments require the services of the most skilled workmen, and enhance greatly the cost of a watch, as it takes many weeks of careful attention to arrive at a satisfactory result.

12. It is this skillful care given in late years to a proper adjustment of the hair-spring, that has imparted to Swiss watches such excellence, that they now rival the best English watches in their performance.

It must be remembered that English watches generally have a chain, and a conical wheel, called a fusee, upon which the chain is wound. When the watch is entirely wound up, the power of the mainspring is considerably increased, and the chain then draws upon the small end of the cone, or fusee, thus equalizing the power of the mainspring upon the moving parts during the time of their running; consequently, there is but little variation in the arc of the balance caused by the increased power in the mainspring when wound up.

In Swiss watches, the chain, fusee, and maintaining-power work, except in few instances, are not used, thus reducing the cost of manufacturing and liability to get out of order. The mainspring is inclosed in a barrel that has teeth upon its circumference, operating directly upon the train. When wound up, the mainspring has a much greater power than when nearly run down; consequently, the arc of vibration of the balance is much greater at one time than at another, which would cause great irregularity in time-keeping were it not for this isochronal adjustment of the hair-spring.

13. If we wish to know how much the world is indebted to the inventor of the balance-spring, we have only to inquire what it does for society, for civilization, for art, for science, for navigation, and for commerce.

We may judge of its value as estimated by different governments by the immense sums of money, which have been offered and paid for improvements on it, and the chronometer in which it is used.

One of the most striking instances of the great value of accurate time-keeping is the facility and certainty with which, by its aid, a vessel can proceed to the locality of a fault in a submarine telegraph-cable, so that it may be grappled at the bottom of the sea, brought to the surface, and repaired. This is now such an ordinary feat that it excites but little comment when it is reported that a cable has been repaired; yet it is one of the greatest marvels of the nineteenth century.

14. The wonderful advance made in watch-manufacturing in this country, the simplicity of their construction, the use of labor-saving machines, and the great number of movements made, excite the astonishment of all the enlightened masters of the art in Europe. The chain and fusee, with the maintaining power, are left out; all the pieces are made to a uniform size, and interchangeable, so that if one piece be lost or broken, it can be replaced, at trifling cost, by sending to the factory for a duplicate. By using hardened and tempered hair-springs and proper adjustments, great excellence is obtained in time-keeping.

But few second-class English watches are now imported into this country, and even the sale of medium-priced Swiss watches has been seriously affected by our home productions.

Foreign manufacturers are already beginning to use labor-saving machines, and adopting the simplest plans of construction. This change, in connection with educated artisans, will have its influence, so that they may still be able in the future to compete with us in cheapness and quality.

15. The influence exerted by schools that have been established in different parts of Europe for teaching the science and art of horology will be very great; there being a marked superiority in the proficiency acquired by graduates of such institutions over those who have received their knowledge of the art by the old method. One of the most interesting displays in the horological department of the exposition was made by the pupils of the French National School of Horology at Cluses, which is located in Savoy, between Geneva and Chamouni. Mr. Benoit, the director, was a pupil of the elder Breguet, and has had charge of this establishment for twenty-five years. It is a government free school, where drawing, mathematics, and the scientific branches of the art are taught by three professors, and where the practical portion is taught by three skillful artisans noted for their proficiency. They had, at the time of the exposition, 72 pupils, and were making arrangements to accommodate 400.

In the display made by this school was shown the individual pieces as they came from the hands of the pupils, from the roughest state to the completely-finished condition, forming the different qualities of movements, and all together showing that the school was producing a superior class of artisans.

Here were exhibited sixteen different forms of escapements, in movements about the size of an eight-day marine chronometer. The escapements were so exposed that their construction and action could easily be seen. One was a remarkable contrivance, intermediate in form between the lever and duplex escapements; the balance making two and a half revolutions. No. 2 was made so as to show the intimate relation between the lever and cylinder escapements. No. 8 was a tourbillon escapement, invented by Mr. Benoit, which gave a very large arc of vibration to the balance.

16. What is usually called the tourbillon, or revolving, escapement is reported to have given the best performance in trials of chronometers extending over three years at the Neufchatel Observatory.

It is not in reality an escapement, but an additional contrivance, which may be as well used with one escapement as another. It was invented by the elder Breguet, whose inventions are as numerous as they are brilliant. Every branch of horology is rich with traces of his genius. The whole escapement and balance are set in a frame-work, which revolves every minute. The object of this is to make the watch correct its own "errors of position" by making the balance pass every minute through all its vertical positions. As an ingenious and delicate piece of mechanism, it excites one's admiration, but leaves a doubt in

regard to its practical utility, being costly to manufacture and difficult to repair in case of accident. The same result in time-keeping can be obtained by using a *perfectly*-poised balance.

17. In Geneva, nearly three thousand persons are engaged in the watch-making and jewelry business, and twenty thousand watches are made annually.

Foremost among the eighteen exhibitors from this city was the house of Patek, Philippe & Co., who displayed a large number of exceedingly fine watches, with the addition of independent seconds, chronographs, and repeaters, fully sustaining their world-wide reputation for fine work. This house, founded in 1839, employs in their establishment over five hundred persons; of these, 348 men and 42 women work at their homes.

Their factory is spacious, well ventilated, provided with reservoirs of water as a protection against fire, and each workman has a window. The number of watches made is about three thousand a year.

They were among the first who constructed stem-winding watches; and since the introduction of this particular manufacture, their business has rapidly increased. The peculiar winding and setting arrangement used is ingenious, elegant, and effective.

In each class of watches, all the parts are made to conform to a certain measure, as in the American system. All of their labor-saving machines are made in their own establishment, and many of them are of their own invention.

The final adjustments in regard to position and temperature are made with great care, as will be seen by the average performance of nine of their watches exhibited in the exposition, which, during forty-five days at the Geneva Observatory, gave the following results: daily variation, six-tenths of a second; difference between hanging and lying, seven-tenths of a second. Among their watches, we noted a chronograph, that recorded minutes as well as seconds.

They also exhibited one of those wonderful little curiosities, a singing-bird about an inch long. Upon touching a spring, it arose through the top of a snuff-box, and, after ending its warbling, suddenly disappeared beneath the cover. In front of the box was a very small watch-movement, which indicated the day of the week, month, &c.

Their chronometers and chronograph-watches in spherical cases were certainly unique affairs.

They also make for the Russian post-office department a large-sized watch, running a week. It is so arranged that the courier cannot open or wind it; this must be done by the postmaster.

18. The firm of J. M. Badollet & Co., of Geneva, made a large display of first-class watches, including independent seconds, chronographs, and repeaters. The cases, engraved by Mr. J. Bonnet, were the most elegant display of the engraver's art in this line in the exhibition.

Chronometer No. 66,401, with fusee, cylindrical hair-spring, and En-

glish detent-spring, gave a daily variation, according to the observatory certificate, of 0.39 of a second.

An average of the performance of five watches on exhibition gave a daily variation of 0.42 of a second.

They claim to have made, previous to the exhibition, a watch, No. 64,025, which was sent to America, whose daily variation was only 0.29 of a second.

19. At the annual trial at the Geneva Observatory, watches remain forty-five days, and are submitted to the following tests:

1st. The mean variation from one day to another is determined during forty-five days. Whatever may be the position or temperature, the limit fixed to enable them to compete is 0.8 of a second.

2d. The error corresponding to a difference of one degree centigrade of temperature is observed, with a limit of 0.2 of a second.

3d. The difference of rate between the horizontal and vertical positions is ascertained, with a limit of 2 seconds.

4th. The correctness with which a watch resumes its former rate after having been placed in a different position fifteen days is noted, with a limit of 1.5 seconds.

5th. The correctness with which a watch resumes its mean rate after having passed through the oven is noted, with a limit of 1.5 seconds.

If a watch exceeds the limit at any one of these trials, it is rejected. The mean of all the trials determines the classification; slight importance being given to the first trial.

20. In the competition this year, (1874,) the first prize was awarded to Messrs. Badollet & Co. for a watch having a lever-escapement, and the balance-spring turned according to the Philipps formula. It was adjusted by Francis Vindone, and during the three months it remained at the observatory its variation diminished.

The first proof gave an error of 0.28 of a second; the second proof, 0.10; the third, 0.4; the fourth, 0.32; and the fifth, 0.54. This is the third year that a watch adjusted by M. Vindone has obtained the first prize.

Of the second prizes, one was awarded to M. Jules Romieux for a chronometer adjusted by himself; the errors of the five proofs being 0.42, 0.01, 0.23, 1.41, and 0.52. The other was given to M. Em Paintard for a watch adjusted by himself; the errors being 0.51, 0.06, 0.07, 0.08, and 1.49.

This year, for the first time, a second competition was instituted. It consisted of taking the mean of all the rates of the watches sent in by each manufacturer, provided that not less than three were submitted. The tests were not so severe for these as for single watches.

Six makers entered into this competition; the best two being so nearly equal that the prize was divided between them. The successful competitors were Messrs. Badollet & Co., who sent in seven watches, six of which were adjusted by M. F. Vindone, and one by M. J. Rainbat; and M. R. Ekegren, with five watches, four being adjusted by M. A. Favre, and one by M. R. Ekegren.

The mean variation of the seven watches of Messrs. Badollet for the first five trials were 0.486, 0.12, 1.877, 1.141, and 0.546; and the five of M. Ekegren, 0.536, 0.078, 1.140, 2.116, and 1.054.

21. The house of Louis Audemars, of Brassus, canton of Vaud, Switzerland, made the most extensive display of complicated watches. Their mechanical execution was of the highest order; it was a superb collection of repeaters, chronographs, and independent-second watches.

The movement having the most elaborate and complicated mechanism was a pendant-winding clock-watch, No. 10834, 21 lines across the dial. It struck the hours and quarters in passing them, and the hours, quarters, and minutes, whenever wished, by pushing a slide. It had an independent-second train, with large double or split hands—one stopping for observations—a small seconds-hand and a one-fifth of a second hand on the same axis. It had two time-dials, full calendar, showing the day of the week and of the month and the moon's phases; a metallic thermometer; a cylindrical hair-spring; anchor-escapement; 45 rubies; treble keyless winding-work, having three mainsprings. Its price was marked at 20,000 francs.

No. 11623 was a pendant winder, 20 lines, and 33 rubies. It repeated hours, quarters, and minutes. It was specially designed for travelers, as it showed upon the dial the time at the principal cities of Europe.

No. 11173, pendant winder, 19 lines, anchor-escapement, independent seconds, repeats hours, quarters, and minutes; shows day of the week, of the month, and the moon's phases; 45 rubies.

No. 10967 was a pendant winder, cylinder-escapement, repeats hours and quarters, eight lines in diameter, marked at 4,000 francs.

No. 11825 was a pendant winder, ten lines in diameter, with anchor-escapement; it repeats hours, quarters, and minutes, and has a compensated balance and 31 rubies. It was marked at 5,000 francs.

The last two are claimed to be the smallest watches in Europe of like character.

There was also in their case, and made by the younger Audemars, a miniature pistol, that was one of the curiosities at the London Exhibition in 1851; it was composed of twenty-two pieces, and weighed only the half of one grain, (32 milligrams.)

All the watches of this firm are made within their factory, or by workmen under their immediate supervision; they use labor-saving machines as much as possible; they claim to be the only house in Switzerland who make repeating-watches complete within their own establishment.

Their first watch, winding and setting by the pendant, was made in 1838, and one was exhibited by them in the London Exhibition in 1851.

Watches with three barrels, winding by the pendant, were first constructed by this house in 1867, and an extra-complicated watch, No. 10834, on exhibition, had this arrangement.

22. U. Montandon and S. Jaccard, of St. Croix, exhibited a case containing 29 watches; they were minute-repeaters, with and without inde-

pendent trains, watches striking the hours and quarters in passing, and small watches highly decorated with diamonds. In construction and finish they were very creditable, but not so remarkable as to require any particular mention.

In the collection of Montandon Brothers, of Locle, there was a clock-watch, that is, one striking the hours and quarters in passing, and the hours, quarters, and minutes by pushing a slide.

Dufour, Zentler & Bro., of Geneva, made an elegant display of fine watches, independent seconds, chronographs, &c.; the highly-ornamented cases of their bijou watches showed exquisite design and workmanship.

B. Haas & Co., of Geneva, exhibited a case of elegant watches, but not of exceeding merit; also a singing-bird in a snuff-box. An exquisitely small watch in the back of a beetle, made of gold and enamel, which exposed the dial when the wings were expanded, was a unique design, and a very small movement set in a ring was another curiosity in miniature-work.

Jeanjaquet & Co., of Neuchatel, made a fine display of repeaters, independent seconds, chronographs, minute-repeaters, &c.

H. R. Ekegren, of Geneva, noted for his carefully-adjusted time-keepers, had on exhibition a case of finely finished watches.

The cases and châtelaines exhibited by G. Sachs, of Geneva, were beautifully made, being in high relief, with colored gold in antique designs.

Many other exhibitors made extensive displays of Swiss work; but as they presented no new features of particular interest, we made no special notice of them.

23. The well-known house of Breguet, rue de la Paix, Paris, made a small but very select display of watches, fully sustaining their high reputation as makers of excellent time-keepers. The cases of their watches are made so that they could not be opened except by a watch-maker, being wound up and set by the pendant, and regulated from the outside. Being so carefully protected from dirt and the action of the atmosphere, they will run a long time without being cleaned.

Their finest work is made by graduates from the French School of Horology at Cluses.

One of the most interesting curiosities in horological art in Paris may be seen at this establishment. It is a very complicated watch, showing many phenomena, and made nearly one hundred years ago by M. Breguet for a marquis in Marie Antoinette's guard. The stipulated price was 25,000 francs, but troublesome times came on and it did not pass out of M. Breguet's possession. It winds itself up by the motion communicated to it by its wearer in walking about fifteen minutes, and shows the surprising degree of skill attained in watch-construction during the last century.

Messrs. Leroy & Sons, Palais Royal, Paris, exhibited an elegant assortment of repeating-watches, minute-repeaters, and chronographs;

some of them constructed with such mechanical perfection as to be valued as high as 7,000 francs.

The house of A. H. Rodanet & Co., of Paris, made a display of handsome watches, one of them, four lines, one-third of an inch in diameter, with twenty-two rubies and anchor-escapement, was a marvelous piece of delicate work. Being a branch of the house of Patek, Philippe & Co., of Geneva, their productions have been fully described.

Japay Brothers & Co., of Paris, made a display of watches with cylinder-escapements, and separate pieces showing the successive stages of manufacture.

These watches are remarkable for their simplicity of construction and the very low price at which they can be sold. The amount of work furnished for a certain price with tolerable time-keeping qualities is remarkable.

M. Gratel, of Besançon, also made a display of watches worthy of mention on account of their low price.

24. The following portion of a report made to the Institute of France, by M. A. N. Breguet, in the name of the Committee on the Mechanical Arts, on cheap watches made by M. Roskopff, will probably be of interest:

"To procure a watch for the workman at a low price, and capable of giving him the exact time, so that he may be at his business at regular hours, was the problem to be worked out; and we here show it has been solved by M. Roskopff, a manufacturer of watches at Chaux de Fonds, canton of Neuchatel, Switzerland, who has completely gained this point of good work, combined with cheapness.

"M. Roskopff makes for 20 francs what he calls the workman's watch. To furnish at this price a strong watch, giving regular time for every day's use, M. Roskopff was necessarily obliged to simplify as much as possible the work done by hand, principally in the finish, and to confine himself strictly to the necessary usefulness of everything concerning the questions of solidity and good application of principles.

"The cases are made in 'hunting' and 'open-faced' styles and very heavy; in the train, he has suppressed one wheel, by changing the number of teeth in the wheels usually employed. The dial-wheels, which move the hands, are placed upon the mainspring box, and the whole mechanism is contained between two plates; the escapement, so essential to a watch, is of the anchor-variety.

"He alone unites two qualities: first, facility of construction in the factory; the shape of every piece permits it to be cut by machinery; secondly, excellence in time-keeping and moderate price. Combining these conditions, it gives the best results of any yet made.

"The watch is used without a key, being wound by the pendant; when it is wound sufficiently, a little vibration is felt in the watch, caused by the displacement of the outer end of the mainspring, as, instead of using the ordinary stop-work to prevent over-winding, he employs the Patek spring, which never needs any repairs.

"Cheap watches are not new; some are made cheaper than those of M. Roskopff, but the quality corresponds with the price. What is new here is the delivery of good and substantial watches at such prices that those of smallest purses can afford to buy them.

"Your Committee of the Mechanical Arts, appreciating the efforts he was obliged to make to arrive at this result, and the services rendered to the laboring classes, has the honor to propose that a vote of thanks be given to M. Roskopff for his communication, and that the present report be inserted in the bulletin, with the design of the watch.

"BREGUET.

"Approved at the sitting, January 24, 1868."

25. In the English department, only three establishments made a display of watches.

V. Kullberg, of London, exhibited some of his finest work. This is a house noted for making highly-finished and well-adjusted watches; but there being no observatory certificates attached to them, we were unable to judge of their excellence in time-keeping.

C. J. Klaftenberger, of London, made a large display of English watches of good quality, but they presented no points of superior excellence.

The well-known house of French & Co., of London, made a very creditable display of their productions, all good work; but we did not see any new features that called for special mention.

26. The most meritorious work from Germany was exhibited by A. Lange & Sons, of Glashütte, Saxony. Indeed, taking the price into consideration, it would be difficult, if not impossible, to find in Europe any that excel them. The construction of their watches combines good workmanship with the application of the most highly-approved principles. The epicycloidal curve of the teeth of the wheels and pinions, and the care used in putting them together, make a depthing that is not surpassed. This is a very important matter in the construction of a train, as all the available power in the mainspring is utilized, so that a spring no stronger than is actually necessary for a correct performance of the escapement may be used.

Their balances are well made, and so constructed that the most accurate adjustments can be made with facility; and once made, they are not liable, in unskillful hands, to be seriously injured. The ruby pin is fastened permanently into the arm of the balance, which is left thicker at this place. The hair-spring collet fits on a projection cut out of the arm of the balance. There are no shoulders or cuttings upon the balance-staff, except at the pivots. It is plainly made, slightly tapering from one end to the other, so that it may be fastened to the balance by being lightly driven into the hole in the center of the arm of the balance. The ease with which a new staff may be put in, and the fastening of the ruby pin in the arm of the balance, are important improvements, as repairs can be made by persons of moderate skill without danger of seriously destroying the adjustments of the balance.

They use the anchor-escapement, and it is executed with the greatest care and skill by the most highly-approved mathematical formula.

Their stem-winding arrangement is constructed upon the best principles; it has strength, smoothness in action, and but slight liability to et out of order by rough usage. Everything about the watch denotes great thoughtfulness and attention to details; and, taking it "all for all," it comes nearer to what a watch, for good time-keeping, at a moderate price, should be than any other that we have ever seen.

27. The house of Carl Souchy & Son, of Vienna, made an interesting display of watch-work made at Chaux-de-Fond, Switzerland, showing the method of finishing the pieces, from the roughest state to the complete movement. A chronometer with tourbillon arrangement, and a clock-watch striking the hours and quarters in passing, and hours, quarters, and minutes when wished for, showed excellent workmanship.

The watches displayed by Austrian exhibitors were principally made in Switzerland. Their niello-work upon the cases and châtelaines was very durable and pretty in design; but their cases too often contained Swiss cylinder-movements of low quality.

28. Switzerland appears to lead all other nations of Europe in adopting labor-saving machines, making every piece in a movement precisely like those in another movement and interchangeable, upon the same principle that watches are made in the factories of our own country.

The English are slow to take up any new features in manufacturing which orignate in another country; but an enterprise has lately been started in Birmingham, aiming at manufacturing watches upon the American system. The fact that they must adopt the new system, if they wish to compete with other nations, has at last been impressed upon them. At a late meeting of the British Horological Institute for the distribution of prizes by the lord-mayor, a short speech was made by Sir John Bennett, in which he said: "Thirty years ago, England was unrivaled in watchmaking, but now foreign nations were not only equaling them, but driving them out of the markets of the world. In clocks, not one in a thousand sold in England itself was of English make. The Swiss were their great and most dangerous rivals; and in order that they might be able to compete with them, they should promote the employment of women in the trade, and technical education should be diffused more widely than was now the case."

The use of stem-winding watches has largely increased within a few years, and the favor with which they are received, as demonstrated by the demand, shows that it will not be a long time before they will almost entirely take the place of the old style of watches, which are wound with a key. The good results obtained by the lever-escapement, and its slight liability to be deranged by rough usage, has led to its general adoption; but few chronometer-escapements are now put in watches, the lever being looked upon as more serviceable for pocket-use.

In the watches made in the United States within a few years, there

has been a tendency to an increase in the number of pieces used in their construction; this is also the case in stem-winding watches, as made by some factories. They could be simplified, be better in use, and made at less cost. The quickness with which inventions are adopted in our country has led to the use of various devices, which, after being tried for a short time, have been abandoned; the same fate awaits some of the forms of construction now used.

But time will settle this matter, and there will yet be constructed a watch embracing all the good points, to the neglect of those that have, after a fair trial, failed to come up to what was expected of them.

That establishment which has the genius to combine the most perfect forms of construction of the different parts into a complete movement will certainly gain a wide and well-deserved reputation, and be richly rewarded.

CHAPTER II.

CLOCKS.

General character of exhibits; Historical; Characteristics of different countries; Electrical clocks; Tower-clocks; Peculiarities; The Great Westminster and other clocks.

29. There seems to have been but little improvement of late years in clocks for astronomical or domestic use. The large display of finely-executed clock-work with Graham's dead-beat escapement shows that it is still most in favor; and although there were many contrivances on exhibition for giving impulse to the pendulum, some acting every half-minute, others every minute, yet it is not probable that any of them will supersede Graham's invention.

Austria far excelled all other nations in the display of large clocks with seconds-pendulums; the large number of movements showing workmanship of the first quality was truly surprising.

The cases of many of them were constructed in the most elaborate manner, and were remarkable specimens of horological cabinet-work.

It will be seen, from the figures attached to them, that their fine clocks are much more costly than one would suppose from the low price paid for labor. This arises from the limited use of labor-saving machines; almost all the parts being constructed by skillful hands.

Clocks that strike the quarters and repeat the hour are extensively made in this country. Clocks going a year with once winding are also numerous.

30. A small house on the exhibition-grounds was exclusively used to show the progressive history of Black Forest clock-making, beginning with the rude clocks of centuries ago, having a verge-escapement and a bar with weights suspended at the ends to serve as a horizontal balance, and ending with the most approved styles of the present day.

Two centuries ago, this industry was confined to the production of a small number of rudely-constructed clocks. Since then, it has steadily increased until it has become one of the most important manufactures in Germany. In 1796, the number of clocks of all descriptions made in the Black Forest district was 7,500; in 1808, the number had risen to 20,000; in 1862, the total was 1,000,000; and, in 1872, was produced the astounding number of 1,800,000 clocks of almost infinite variety, from the antiquated wooden movement, going only twelve hours, to the costly regulator, and embracing specialties for nearly every country in the world; 400,000, or nearly one-fourth of the whole, were made at Furtwangen.

31. The greater number exported to Great Britain are provided with weights and chains, and go twenty-four hours. Switzerland is a customer principally for trumpet and cuckoo clocks.

The demand in Austria is for the better class of chain-clocks, while Italy takes almost exclusively spring-clocks.

France has a predilection for those of a large size, which are sold under the name of Swiss clocks. To Belgium and Holland are sent clocks with bronze cases, ornamented with tin and porcelain shields. Russia is a large customer for the best eight-day clocks, and is also the depôt from which some of the Asiatic countries are supplied with the Black Forest manufactures.

Turkey and Malacca take ship's clocks as well as cuckoo; Sweden, Norway, and Denmark show a preference for hexagonal and octagonal cases; Spain and Portugal take chain-clocks only.

Even our own country, where clocks are made in immense numbers, and as cheaply as any place in the world, imports Black Forest goods largely, chiefly cuckoo-clocks and regulators. Mexico and South America take a fair proportion of cuckoo and spring clocks. India, China, and Japan demand cuckoo and ship's clocks, and a better manufacture with cases after the English pattern.

There are, in this district, 1,429 clock-manufacturers, employing 7,526 hands; but it is computed that altogether 13,500 persons are dependent upon the clock-trade.

Even with the whole world for a market, the distribution of two millions of clocks a year is an achievement that the founders of the Black Forest clock trade would certainly never have anticipated. The great stimulus given to clock-making in this district within the past thirty years was in all probability owing, in a measure, to competition with cheap clocks made by machinery in the United States.

32. Franz Zajicek, of Vienna, exhibited a well-made and very complicated astronomical clock, showing many phenomena. It had a Graham escapement, and a gridiron-pendulum with a lenticular bob highly ornamented with designs from the zodiac. The movement was a wonderful complication of wheels, pinions, and levers, and was inclosed in a massive and elaborate case of cabinet-work, forming altogether the most imposing piece of horological mechanism in the exhibition. It was marked at 25,000 florins—about $12,000.

The Brüder Stern, of Vienna, exhibited a large number of highly finished regulators, with Graham escapements, and steel pendulums compensated with mercury. One running three months was marked 3,400 florins; another running one year, with time-train only, was marked at 3,150 florins. The cases were magnificent in design, and ornamented with exquisite inlaid work.

In Carl Stifft's display was a fine regulator, with a wooden pendulum, in an elegant case, which struck hours and quarters. It was marked at 1,800 florins. In the Austrian clocks, the hour is generally struck upon a spiral piece of steel.

Anton Schlesinger, of Vienna, displayed several regulators of exceedingly good workmanship and elegantly cased; the highest price being 1,300 florins.

In the collection of Leopold Seibert, of Vienna, there were two highly-finished regulators; one, running a year, struck hours and half-hours; the other also ran a year and struck hours and quarters. Metallic pendulums with mercurial compensation were used. The cases of these clocks were magnificent specimens of cabinet-work.

Several makers are adapting the wooden pendulum to some of their finest work. If this material could be relied upon for regularity in its action, a very simple compensated pendulum could be made of it by using a lead bob about 14 inches in length; but from many experiments that have been made with wooden pendulums prepared with the greatest care to resist moisture, &c., it has been found that they cannot be depended upon for accuracy.

An iron rod with zinc compensation has been received with much favor in late years, and has given such good results that the clocks prepared by the English government for the transit-of-Venus expeditions have such an arrangement in preference to the usual jar of mercury.

Carl Souchy & Son, of Vienna, exhibited some well-made regulators with jeweled Graham escapements, the highest price being 850 florins; the cost of the movement alone, which goes one year, was 300 florins. His cases in light-colored woods were artistically designed and well made.

J. Freitag, of Vienna, showed pieces in course of transition to completely-finished clocks. A large portion of the work was struck out of sheet-metal with dies, showing the adoption of a labor-saving process.

Carl Urban, of Vienna, exhibited an elegant regulator with time-train only, running one year, having steel pendulum compensated with mercury; the price was 700 florins.

In J. F. Schondorfer's collection, there was a regulator with a jeweled Graham escapement; the pieces lying separate, so that their highly-finished condition might be seen. There was also a regulator, with pivot-holes and pallets jeweled, running one month.

Professor Fischer, director of the Horological School in Vienna, displayed separate pieces of a clock, which showed a high degree of perfection in form and finish. Well-executed drawings of escapements, pendulums, &c., by the pupils of the school, showed their proficiency in this art.

Carl Hartel, of Vienna, exhibited a large and well-made regulator, striking hours and quarters; price, 2,400 florins.

A fine regulator, striking hours and quarters, with gridiron-pendulum, made by Franz Lengsfeld, of Vienna, deserved special notice for fine workmanship; price, 2,000 florins.

L. Lenbach, of Munich, exhibited a large and well-made regulator, with an escapement that seems to be considerably in favor in Bavaria. The pendulum is suspended upon a knife-edge. The upper part of the pendulum is extended above the point of suspension; at this end, there is a ratchet-wheel with thirty teeth; at every vibration of the pendulum, a click, which is fastened to the movement, drops into the wheel and

moves it one tooth; in a minute, the wheel makes a complete revolution; a pin fastened to the side of the wheel then comes opposite a detent, which lets off the train, giving impulse to the middle of the pendulum. It works very prettily, but is not likely to take the place of other well-known forms of construction.

Samuel Kralik, of Pesth, had a very creditable display of clocks showing excellent workmanship. In this collection were sixteen well-made models of different escapements for demonstration; the balances being about four inches in diameter.

Two large-sized mantel-clocks were meritorious for good workmanship and ingenuity. One had a large balance, with two escapement-wheels, acting something like a Swiss chronometer; the teeth of one of the wheels acting on the detent, and the other upon the roller-impulse jewel. The other clock had a pendulum; the escapement acting upon three jeweled detents, which, although delicate and giving impulse in one direction, was too complicated for practical use. Three large regulators had compensated pendulums constructed in an elaborate manner; one was marked 600 florins. A small regulator, with two barometer-tubes for a pendulum, was a novelty. The tubes vibrated upon a knife-edge adjusted about six inches below the top of the mercurial columns. All the rest of the regulators had Graham escapements.

Franz Läschinger, of Ofen, exhibited a finely-constructed regulator, with time-train only; price, 600 florins.

S. Blum, of Constantinople, exhibited a clock, and a separate pendulum, curious in design, but rude in mechanical execution.

33. Switzerland displayed a large number of clocks for domestic use, including some ingenious trumpet and cuckoo clocks; but there did not appear to be anything particularly new about them.

In France, mantel-clocks are a speciality. For elegance of design, good workmanship, and moderate price, they are not excelled by any nation.

The house of Breguet, of Paris, had a small but interesting display. A mantel-clock, with a large tuning-fork to control the escapement, was a great novelty. This contrivance is the invention of Mr. A. N. Breguet, and the mechanical execution of the clock was by Mr. Edward Brown. The tuning-fork was about a foot long, and gave one hundred vibrations in a second. About midway upon one of the prongs, there was a sliding-weight, by which the number of vibrations could be regulated. Projecting from the end of the prong was a small pin, which acted in the fork of a lever. The lever made one hundred vibrations in a second, corresponding to the tuning-fork. Attached to this lever was a pair of pallets, which acted upon an escapement-wheel having ten teeth, and making four revolutions in a second. The tuning-fork in this case regulates the speed of the train. The pallets and escapement-wheel act in a manner similar to the escapement of the striking-train in a repeating-watch. It was found by experience that the vibrations of the fork should be confined to about one degree to give the best results. These

vibrations are so completely isochronal that an increase of power, from 4 pounds to 60 pounds on the train, made no difference in its time-rate. The second-hand made a complete revolution in one second. The dial being divided into one hundred parts, with a proper contrivance for starting and stopping, it might be of service in recording time to the hundredth part of a second.

This house also exhibited a beautiful mantel-clock, with a double escapement-wheel so constructed that both pallets received an outward impulse; the front pallet being dispensed with. The mechanical execution of this clock was probably the best in the exhibition; and the remontoir arrangement, which acted every fifteen minutes, was remarkable for its ingenuity and beauty of construction. The pivot-holes of the escapement were bouched with platinum. Oil having no action on this metal will preserve its purity for a long time.

Leroy & Sons, of Paris, had the largest display of first-class, richly-gilded, and enameled mantel-clocks. Some of them had novel and expensive escapements. A few were upon the gravity-principle, and others were of ordinary construction. Prices ran from 10,000 francs down to moderate prices.

Guilmet, of Paris, displayed two clocks that attracted considerable attention. Each had a female figure standing upon the top of the clock, holding in her hand the upper end of a pendulum, which vibrated to and fro without any apparent cause. The round base, upon which the figure stood, rested upon a pivot, and was connected with the escapement. It had a slight motion upon its axis, imperceptible to an observer. By this means, the point of suspension was moved to and fro at every movement of the figure, which kept the pendulum in motion.

A. Bailly and Theo. Leroy, of Paris, exhibited well-made regulators, with Graham escapements and mercurial pendulums.

The French have a speciality in beautiful little traveling-clocks, at various prices, some of them very expensive.

Kiek & Casseries, of Amsterdam, exhibited a well-constructed regulator, and J. Spouhase, of St. Petersburg, a regulator in splendid malachite case, but the movement was of ordinary construction.

34. The United States were represented by only one exhibitor of clocks for domestic use, the Seth Thomas Clock Company of New York. In this collection were all the forms and qualities of clocks manufactured by this establishment.

Although this display was a prominent feature in the department, it did not give a correct idea of the degree of perfection that American makers have arrived at in this art.

It was much to be regretted that there were none of our fine astronomical clocks and regulators on exhibition, as they would have demonstrated that we are second to no nation in this industry, either in quality or price.

35. Electrical clocks.—Probably the first clock whose pendulum received its impulse from electricity was contrived by Mr. Bain. The

bob was made with a hole through it, and passed over two soft-iron cylinders, alternately magnetized by an electrical current at each beat of the pendulum. This principle has been adopted to a considerable extent, and, with an earth-battery made of copper and zinc plates buried in the ground, satisfactory results have been obtained. Essentially the same principle can be applied to a common pendulum-bob by making two horizontal arms from it enter two hollow magnets; a very small amount of electricity applied through a standard clock to a common one with this kind of pendulum will be sufficient to keep them in exact agreement.

An accurate regulator can be made to control a large number of secondary, or sympathetic, clocks, either upon the foregoing plan, which has the great advantage of not requiring absolute certainty or continuity of electrical action at each beat of the pendulum, or by electricity operating upon their escapements so as to cause the pallets to move the escapement-wheel, the pinion of which drives the wheels to which the hands are connected. This latter system has also been extensively applied.

A gravity-escapement, invented by Mr. Shepherd, in which the pallet is raised by a temporary magnet, and then acts on the pendulum when swinging in one direction, is well spoken of. He made another important improvement by arranging his magnets so as to repel and attract alternately, instead of leaving the separation to be done by gravity.

Single clocks, going entirely by electro-motive force, have a certain fascination about them at first sight, being apparently a kind of perpetual motion; but, in reality, it only illustrates the rather uncertain communication of electrical force derived from chemical action; and, notwithstanding the large amount of thought and mechanical skill that have been expended in this direction, it is not likely, except as a curiosity, that it will supersede, for ordinary use, the old methods of applying power, that is, by means of a weight or spring wound up at certain intervals.

An electrical clock with striking-work, exhibited by Autenreith & Himmer, of New York, United States, would have attracted more attention if it had been in working condition, so as to show its mode of action. There was considerable merit claimed for it, and it certainly presented an appearance that predisposed one in its favor. We made some effort to get it into a more presentable condition, but without success.

E. Deschiens, Dumoutin and E. Barbier, and A. Postel & Co., of Paris, made displays of electrical clocks with different systems.

Matth. Hipp, of Neuchatel, exhibited various forms of electrical clocks. His large clock was something on the Bain principle. A horizontal armature was fastened to the lower end of the bob of the pendulum, with a temporary horseshoe-magnet fastened vertically beneath it. As the pendulum vibrated, the armature passed over its poles. About the middle of the pendulum was a small hanging click that caught upon a spring and closed an electrical circuit when the motion of the pendu-

lum decreased to a certain arc. Having received an impulse from the magnet, the pendulum would vibrate from five to seven beats before its arc would diminish enough to allow the click to catch hold of the breaker and close the circuit again. This arrangement appeared to work very well, and is generally adopted in the construction of his clocks.

J. Ferrucci, of Udine, Italy; A. Gerard, of Luttich, Belgium; Paul Miller, of Cologne; J. B. Kerz, of Mayence; and B. Egger and M. Illitsch, of Vienna, exhibited well-made electrical clocks, but no improvement of particular merit.

An electrical clock with registering-apparatus, for astronomical purposes, by Professor Arzberger, of Brunn, was an interesting piece of mechanism, and appeared capable of doing all that he claimed for it.

36. TOWER-CLOCKS.—The small number of tower-clocks exhibited was remarkable for an exhibition of this magnitude. Neither England nor France, both of which nations excel in this work, was represented. A few makers in our own country turn out mechanism of this class that is not surpassed anywhere for excellence in principles of construction and good workmanship; yet not a single movement was exhibited in the United States section. Tower-clocks, if constructed properly, are capable of a wonderful degree of accuracy; but, as a general result, their performance is unsatisfactory. Not unfrequently cases similar to the following occur: the hands may show quarter to four, and the hammer strike thirteen on the bell; it is by this combination that it is indicated that it is 3 o'clock precisely. The cause of this trouble is often owing to faulty principles in construction; some escapements being liable to trip and throw the clock out of time. The striking-arrangement may also have defects. These faults, with an incompetent person to attend to the clock, produce results that are very much at variance with the degree of correctness expected in a piece of mechanism of this kind.

37. Being an expensive piece of construction, often costing several thousand dollars, it is advisable that its peculiarities should be more extensively known.

One of the ablest and most reliable of English authorities says: "I suppose it may be said without exaggeration that there is no machine made and sold in England, perhaps no article whatever in common use, which so few of the purchasers know how to judge of, and therefore in which imposition is so easy, as turret-clocks."

In constructing these clocks, it is generally thought it is only necessary to enlarge the machinery of an ordinary house-clock, and the end is accomplished; that they differ from small ones only in the weight of the hands and of the hammers. But there is a very important fact that interferes with the soundness of this conclusion. As the strength of machinery is increased, its weight is increased in a ratio as much higher as the cube is higher than the square of either of its dimensions; and when the weight is increased, the friction is increased—an important element to be considered. In small clocks, the force, or weight, required to work

a hammer weighing a couple of ounces is generally about the same as that required to keep the pendulum in motion; and so the two parts or trains are about equal in strength. In large clocks, the lifting of the hammer generally requires a much larger amount of power than that needed to drive the hands and pendulum; they should, therefore, have much heavier and stronger machinery.

Clock-makers make a great mistake in making the trains of uniform size, as the striking power is then so weak that only a very small bell can be used properly. Clocks constructed in this manner, placed in the hands of some persons, they try to improve their striking qualities by adding weights until the capacity of the clock is overtaxed, and in many instances serious results have followed such an experiment.

In some clocks that have not been made in proper proportions, it has been found advisable to change the striking part from one week to one day. It is said that there are, with but few exceptions, no tower-clocks in England strong enough to perform the work properly, where pins in the second-wheel are used to raise the hammer. Some have been changed so that cams or pins on the great wheel raise the hammer, thus making it strike the hours powerfully for one day, instead of feebly for a week.

For bells weighing above a ton, it is advisable to have a striking-train wound up every day, except where there is an unusually long fall for weights. This may be shown thus: A 40-pound hammer raised to a height equivalent to 5 inches is the least that will bring out the sound properly with a bell of that size; and that is too little if the bell is a thick one. Under the most favorable circumstances, and striking from the great wheel, it may be reckoned that the actual clock-weight will have to be double the theoretical; or,

$$40 \text{ pounds} \times 10 \text{ inches} \times 78 \times 15 = 468000$$

for $7\frac{1}{2}$ days, which will be 975 pounds with a fall of 40 feet; and if several cranks or pulleys are used, the weight will have to be much more. Such large weights are not safe in most places, and require a very strong clock to sustain them; besides, in some striking-trains, the weight required is nearly three times that calculated theoretically.

The conclusion has thus been arrived at, that the best plan is to make the time-train carrying the hands run a week with once winding, and the striking-train one day, or four days at the farthest, for large bells.

Bells weighing over a ton require hammers about one-fortieth of their weight to bring out the tone properly. Generally, they weigh much less, and therefore we seldom hear a bell sound so loud, when the clock is striking as when ringing.

Cage-frames, consisting of vertical and horizontal bars, in which the wheels are placed over each other, are giving way to horizontal ones, in which each wheel can be removed without disturbing the others by unscrewing and taking out the bushings. The French commenced making clocks on this principle nearly thirty years ago, and where there is room the method is to be preferred.

In England, the introduction of iron in place of gun-metal or brass

has reduced the price, so that clocks formerly costing £500 can now be put up for £150. For keeping time only, without regard to appearance, iron without doubt will do well for the larger wheels at a great saving in cost. Friction, liability to rust and break, have been urged against iron wheels, but with the gravity and remontoir escapements, the increased friction will not affect the time-keeping qualities. As to rust, all, except the acting surfaces, may be painted and oiled, as in other iron-wheel machinery. In spinning-machines used in factories, cast-iron wheels may be seen much smaller than those required in a large clock, and they perform admirably.

Remontoir-trains have, in late years, to some extent taken the place of ordinary trains; they have been much in favor. In this arrangement, the hands usually move every half-minute, at which time the remontoir-train is wound up enough to run the escapement-wheel half a minute; at the end of that time, the hands suddenly make an advance, and the remontoir is wound up again, and so on.

The escapement-wheel, which may be the usual Graham dead-beat pattern, is moved either by a weight or spring, and is detached from the variable force of the train carrying the hands. Some of the French manufacturers introduced, more than twenty years ago, a simplified form of gravity-remontoir, which gave good results when carefully made. There are several forms of remontoir-trains, which have done well; they may be found fully described in recent works on horology; but even these are being superseded by gravity-escapements, which have done well in regulators, and in turret-clocks have certainly given wonderful results.

It is asserted that altering old turret-clocks by putting this escapement in place of the usual dead-beat, and using an iron pendulum compensated by a zinc tube in place of the ordinary wooden one, has reduced the variation from minutes to seconds. These gravity-escapements, it is said, have an error partially compensating the barometrical one, which in some clocks amounts to nearly a second a day for a rise of one inch of mercury in a barometer; whereas the rate or error of the usual dead-beat escapement is in the same direction as the barometrical one.

38. Through the kindness of the commissioner of public works, we were enabled to examine the great Westminster clock in London; a privilege seldom granted. This clock having been constructed with the greatest care, upon the best scientific and mechanical principles known, and having given the best results ever obtained, it may serve as a valuable guide to those wishing to construct clocks reliable in performance.

Lord Chief-Justice Coke tells us that the first Westminster clock was paid for by a fine imposed upon a corrupt predecessor of his own in 1298. In A. D. 1365, a stone tower was erected here by Edward III, which contained a clock that struck the hours upon a great bell. There is no doubt that the place where the present clock-tower stands has been for more than five hundred years the site of a great public clock.

The present clock, designed and its construction superintended by Mr. E. B. Denison, under a contract between Mr. Dent and the commissioner of public works, was first set going in May, 1859; the total cost being £22,050. The actual cost of the movement and striking-work was £4,080; of the hands and dials, £5,334; and of the bells, about £6,000. The balance of the fund was expended in experiments and failures, the results of opposition and of suggestions, which are said to be inevitably met with in the production of any large public work in that country.

The horizontal frame that supports the three trains is 15 feet 6 inches long and 4 feet 7 inches wide. The time-train is wound up once, while the hour and the quarter trains are wound up twice a week.

The great striking-wheel has ten circular cams, 2½ inches wide, with hardened-steel faces. The cast-iron head of the large hammer weighs 780 pounds, and is lifted 9 inches vertically, or 13 inches from the bell. Each striking-weight weighs nearly a ton and a half, which is about half what would have been required if the usual striking-work with pins had been used instead of cams to raise the levers. Wire-ropes, half an inch in diameter, are used to sustain the weights, and also to connect the clock with the hammers.

The quarters, which are struck upon four bells, weighing 8,000, 3,700, 2,800, and 2,350 pounds respectively, repeat the celebrated St. Mary's chimes at Cambridge. The first great bell was a defective casting, and cracked. The present one will probably be replaced before long, as it is porous, unhomogeneous in composition, and partially cracked through. It is 9 feet in diameter, and weighs 30,000 pounds.

The mass of weight, that has to be moved in a clock as large as this at each beat of the pendulum, is so great—being two tons—that it requires more power in the weight, than would be safe acting directly on the escapement. To overcome this difficulty, and to completely isolate the pendulum from the great and varying pressure of the train, various contrivances have been used. The first tried in this clock was the three-legged "*dead*" escapement. The escapement-wheel had only three teeth, or, more properly, arms, and weighed 73 grains, about one-sixth of an ounce avoirdupois. After running six months, a three-legged *gravity*-escapement was put in. This worked very well; but, in 1852, a four-legged gravity-escapement was substituted for it, and retained until about 1860, when the present double three-legged escapement was put in. It is, in all probability, the simplest and most complete escapement yet invented for giving regular force to the pendulm independent of the train. The pressure of the teeth, or arms, on the stops of the pallets is four ounces. In an ordinary dead-beat escapement, it would have been over four pounds.

The whole pendulum weighs 680 pounds; its length is 14 feet 5 inches. The zinc compensation-tube is 10 feet 5 inches long, and is made of three tubes, one within the other, and drawn together until the thickness is half an inch. The center of gravity of the bob is about 8 inches below, the center of oscillation. Owing to the weight of the compensation-

tube, the pendulum-spring is 3 inches wide, 5 inches long between the chops, and one-sixtieth of an inch thick.

To alter the clock less than four seconds, a collar is fixed on the pendulum 4 feet 10 inches from the top to carry the regulating weights. One and a half ounces placed there accelerate the pendulum one second a day.

There is also a large weight of six pounds fitting around the pendulum, except on one side, so that it can be lifted off. If the clock is too fast, this weight is carefully removed while the clock is being wound up, until it has lost the time desired—about a second in a quarter of an hour—and it is then put on again. If it is too slow, the clock may be accelerated by laying on another weight.

There is no temperature-error, and no barometrical error can be discovered. The absence of the latter is owing, in some measure, to the fact that the pendulum swings through a larger arc than usual—2½° on each side of zero—and the circular error goes in an opposite direction to the barometrical error.

The reports of the astronomer-royal show that its variation is less than one second a week, and that it has been only 3 seconds wrong on 2 per cent. of the days of observation.

The clock reports its time to the observatory at Greenwich twice each day by electricity. Its rate is checked and recorded, and any error is telegraphed and corrected by the means before mentioned.

The weekly variation of the Royal Exchange clock, which the astronomer-royal had at one time justly described as the finest clock in Europe, was four seconds, and that of one of Mr. Dent's best regulators two seconds. This is therefore a considerable advance in time-keeping.

The dials consist of a cast-iron frame-work, forming the divisions and figures, filled with an expensive kind of opalescent glass; the minute-spaces are one foot square, and the figures two feet long.

The center of the dials being 180 feet from the ground and illuminated at night, the time can always be seen at a long distance. Each of the four dials is 22½ feet in diameter, of nearly 400 square feet area, and is, with the exception of one, having only an hour-hand, at the cathedral of Malines, the largest in the world.

39. A complicated remontoir, with pin-wheel escapement, exhibited in a clock made by Haak Brothers, Rotterdam, seemed to have some good qualities. The wheels and other brass-work showed good workmanship, but nothing remarkable in construction.

C. Weiss, of Posen, exhibited a large-sized movement with three trains. Connected with the time-train was a spring-remontoir of two wheels and Graham escapement, inclosed in a glass case. Twenty years ago such an arrangement might have met with favor; but simpler forms of construction are now preferred.

There was a variety of escapements in the collection of J. Nehr, of Munich; some with double escapement-wheels, others with two pendulums, but none showing any practical advance in the art.

J. Mannhardt, of Munich, has been awarded many medals for his productions. His clocks have cage-frames, and trains uniform in size; they would do very well for places requiring small movements and no great accuracy in time-keeping. He uses the short wooden pendulum, with a rachet-wheel revolving on a pivot fastened near its point of suspension. A click fastened to the frame-work drops into the wheel and moves it one tooth forward at every vibration of the pendulum. When the wheel has made half a revolution, a pin on its side discharges the train, giving impulse to the pendulum, and moving the hands. It is probably better than the old dead-beat, but not equal to some modern gravity-escapements.

Several clocks from Silesia had odd and heavy escapements, and were entirely behind the age.

A few other makers from Germany and Austria exhibited specimens of their work; but, taking all the movements in the exhibition together, they were far from correctly representing the advanced state of turret-clock making at the present time.

CHAPTER III.

BALANCES AND MICROSCOPES.

BALANCES; SENSIBILITY; EXHIBITS; MICROSCOPES; RECENT IMPROVEMENTS; EXHIBITS; AMICI'S DEVICE.

40. BALANCES.—Probably in no class of instruments have attempts to invent new forms or arrangements met with less success than in balances used as instruments of precision. Being a very important, in fact, an indispensable, instrument to the analytical chemist and the assayer, the smallest improvement is a matter deserving notice.

With regard to the great sensibility of some balances, as shown by the smallness of the weight required to turn the beam, but little more can be accomplished, as several makers have made them so delicate as to turn with $\frac{1}{10,000,000}$ part of their load. One made by Saxton, and presented by the Government of the United States to that of France in 1851, indicated a difference of one unit in 20,000,000 in each pan.

In order that a balance with a beam 20 inches long may indicate the one millionth part of its load, we must, at the most, have—

$$\frac{1,000,000}{1,000,001} = \frac{a - x}{a + x}, \text{ or } \quad x = \frac{10}{2,000,000} \text{ inch.}$$

Within the same length, the two arms of the beam must be adjusted to equality, if the balance is to have the above degree of accuracy. As this length is not appreciable by the microscope, it will give some idea of the skill attained by the balance-maker in making his adjustments

Any good balance should weigh with certainty to the $\frac{1}{100,000}$ part of its load. Even the delicacy of such a balance is in advance of what may be required of it, as the result of few chemical operations can pretend to an accuracy of $\frac{1}{10,000}$ part; therefore, it is the accessories facilitating the ease and rapidity with which accurate weighings may be made, which now more particularly require attention.

41. Germany was represented by fifteen exhibitors. Among the most prominent were the following well-known makers: F. Hugershoff, of Leipzig; A. Sauter, of Ebingen; A. Oertling, of Berlin; Reimann, of Berlin; Schickert, of Dresden; Kern & Sons, of Oustmettingen; and Staudinger, of Giessen. Only about one-third of the exhibitors presented balances showing good workmanship; although some of the others may have been adjusted to great accuracy.

The balances that pleased us most were made by Hugershoff, of Leipzig. They were unsurpassed in mechanical execution, judicious proportions, and attention to all the details required in making accurate adjustments. They had large pans, and beneath them an arrangement consisting of two large camel-hair brushes mounted upon the ends of levers; by means of these, the pans could readily be brought to a state of rest.

In the French department, Collot Brothers and E. Hardy, of Paris, exhibited some well-made balances. The latter claimed for a balance carrying 50 grams an accuracy of $\frac{1}{100}$ of a milligram.

Although there are low-priced balances made in Europe giving good results, yet, in purchasing a first-class balance, when the custom-duty is added to the foreign article, it can probably be obtained of our own manufacturers as cheaply and as well made.

42. MICROSCOPES.—The success attending the efforts that have been made within the last thirty years in improving and perfecting the microscope, so that it now gives clear and correct views of objects formerly deemed doubtful and unsatisfactory, has given a great impetus to microscopical investigations, and enlarged greatly the number of enthusiastic workers in this fascinating branch of physical science.

The display of these instruments in the exposition was almost entirely from Germany and France. None of England's celebrated makers were represented; nor was our own country, whose opticians are well known for productions of the highest order, placed in a proper light in this *concours* of nations.

43. The photographs of test-objects, taken through Dr. Hartnack's microscopes, were certainly remarkable specimens, showing the great perfection to which he has carried the art of making objectives with the four-system arrangement. The performance of his instruments fully sustained his widely-extended reputation for producing objectives of the highest order of excellence.

Seibert & Kraft, of Wetzlar, made a display of excellent microscopes with accessory apparatus. After a thorough trial of their objectives, we can say that they deserve to be ranked with the best that are made, and the price, considering the quality, is the lowest that we have been able to find. Their No. V, equal to about an English one-sixth, has given them much reputation by its remarkable resolving powers upon the highest object-tests. Their objectives are admirably arranged as to angular aperture, so as to give the best working power to each objective in relation to the kind of work in which it is likely to be used.

The mechanical execution and artistic proportions of their stands are unsurpassed, and the working arrangements are of the most satisfactory character.

L. Bénèche, of Berlin, also exhibited instruments of much merit. The good quality of his object-glasses has recently attracted considerable attention, particularly his No. 7, which has given results deserving special notice.

In the magnificent display of optical apparatus by G. & S. Merz, the successors of the renowned house of Fraunhofer, of Munich, were two microscopes of great merit.

F. W. Schiek, the oldest maker in Berlin, exhibited some very good work at a moderate price. His stands and objectives somewhat resemble Dr. Hartnack's in appearance.

Schmidt & Haensch, of Berlin, and R. Winkel, of Göttingen, also exhibited well-made microscopes and other optical apparatus.

S. Plossel & Co., of Vienna, who have been making good microscopes for nearly thirty years, made a handsome display of optical instruments.

A. Nachet, of Paris, displayed some of his best work. His latest large stand is somewhat complicated, but is admirably constructed. His student's microscope, whose chief peculiarity lies in its stage, has been acknowledged by the best authorities to be the most perfect of its kind that has ever been devised. The quality and price of his instruments are so well known as to scarcely require mention.

C. Verick, of Paris, a pupil of Hartnack, exhibited some fine objectives. His stands resemble very much in construction those of Dr. Hartnack, and his work in general has considerable merit.

44. The immersion-principle, first devised by Amici for high powers, has very much increased the usefulness of objectives, and is now adopted by all the best makers. It has been applied with such success to powers as low as one-sixths with high angular apertures, that they have lately been made to resolve the lines on the *A. pellucida*, which are about 92,000 to the inch. These objectives are sometimes supplied with dry fronts, and others will work either wet or dry by corrections made with a screw-collar.

Comparatively low powers, with wide angular apertures, can now be made to do the work for which the highest that can be constructed have been supposed to be necessary. One-eighths have recently been made, which, with deep eye-pieces amplifying 2,000 times, give views of *P. angulatum* surpassing in beauty and brilliancy any ever seen before.

Some opticians are working on a plan precisely opposite to the above, by reducing the angular aperture, securing great working distance and penetration, and yet obtaining an amount of resolving power hitherto supposed to be exclusively the property of far larger-angled glasses. One-sixths, with an angular aperture of 68°, have been made that give admirable definition of *P. hippocampus*, and show the transverse markings on *S. gemma* resolved into beads, showing how much more than has been expected can be done on the plan of a small angle and great working distance. Even one-fourths, with 48° angular aperture, have been made so perfect as to work well with deep eye-pieces.

Amid the great variety of object-glasses that are now made, the microscopist has a wide range for making a selection in adapting his instrument to the kind of work in which he may be making his investigations; and, unless some new principles be discovered, microscope-making has about reached its limit of perfection. The very low price at which the best German instrument, which will rank with any that are made, can be purchased will now enable them to reach the hands of persons of moderate means, and thus largely to increase the number of investigators in the beautiful science of microscopy.

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H.

INSTRUMENTS OF PRECISION.

R. D. CUTTS.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

INSTRUMENTS OF PRECISION.

BY

RICHARD D. CUTTS

HONORARY COMMISSIONER OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
Sm 1875.

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INSTRUMENTS OF PRECISION.

1. In conformity with the Austrian classification, Group 14 was composed of instruments of precision and of the medical art, and was divided into three sections, each of a different, though analogous character. By reference to the details of the sections as arranged and published for the guidance of the jurors, it will be seen that Section A included, besides other classes of instruments, all those designed for practical geometry and astronomy. The remarks which follow will be confined to such of the instruments on exhibition as were specially applicable to surveying, geodesy, and field-astronomy; and in which there was either an improvement claimed, or some difference from those employed in similar operations carried on in the United States, principally in the survey of the coast.

2. Of the thirty different countries represented at the Vienna Exhibition, there were ten which exhibited one or more instruments of the particular kind referred to. These were Austria, North Germany, Great Britain, France, Denmark, Russia, Italy, Brazil, Switzerland, and Japan. In the official list of entries on the part of the United States, there were one or two articles under this group, which might have been introduced in this connection; but, after a fruitless search, it was ascertained that they had been withdrawn by their proprietors on the ground of the uncertainty of the protection of their patent rights by the Aus trian government.

3. The plan of the building rendered it necessary that the arrangement of the Exhibition should be by countries without regard to industries; and, in consequence of the magnificent scale upon which the plan was carried out, groups of similar articles were located more or less widely apart, in some cases at distances of a half mile; nor were the groups always marked, or articles of the same class strictly confined to their appropriate group. The hunting-up, therefore, of any particular article through the exhibits of different countries required more time than at previous exhibitions, and was attended with a proportional amount of the peculiar fatigue incident to such duties, or pleasures; while, in a more important point, the separation or want of juxtaposition in articles of the same class, made it impossible to institute close comparisons, or to decide with any degree of certainty in regard to superiority in skill and workmanship. This difficulty must have been specially and severely felt by the jurors.

4. It may be here stated as a general fact that no marked improve-

ments in surveying or astronomical instruments were found or claimed to have been made since 1867, if we take the Vienna Exhibition as the exponent. In this connection, however, it should be borne in mind that some of the best known and most skillful mechanicians in Europe were unrepresented at the Exhibition. Among these may be mentioned Brünner and Secretain, of Paris; Pistor & Martin, of Berlin; Repsold, of Hamburg; Traugott, Ertel & Son, of Munich; and Simms, of London.

5. THEODOLITES AND TRANSITS.—The theodolites exhibited were generally small, being of the class suitable for running lines and for carrying on a triangulation of the third order. Their circles rarely exceeded six inches in diameter. Of the larger class, strictly appropriate for geodetic work, Starke & Kammerer, of Vienna, had the only 12-inch theodolite seen in any of the collections. The reason for this may have been that the demand for instruments of that size and construction is so limited that they are only made to order.

6. In the *atelier* of Brünner, at Paris, two 18-inch theodolites were under construction, and nearly finished, for the government of Spain. The arrangement and solidity of the arms carrying the four reading-microscopes appeared to be excellent, and the accuracy of the divisions on the circle was, according to Brünner, all that could be desired. In Germany, the graduation of Repsold, of Hamburg, was considered to be the most perfect of any mechanician in Europe.

7. The instrument generally employed in the geodetic operations carried on by the northern nations of the continent is the "universal instrument," which, as its name implies, is constructed to perform the combined duties of a theodolite, transit, and zenith telescope. Of this class of instruments there were many exhibitors, among whom Starke & Kammerer, of Vienna, took the lead, presenting four different sizes, all apparently of excellent workmanship.

8. As a general principle, and one which has been adopted in the geodetic work connected with the survey of the coast, a field-instrument constructed to perform a single duty will give the best results, will be the least liable to injury or derangement by transportation, and to the necessity of re-adjustment during its use. Nevertheless, the "universal instrument" has many good points, and for this reason, and on account of the apparent and continued preference given to it in Germany and elsewhere, it may not be amiss to refer to the advantages and disadvantages attending its peculiar construction.

The prominent characteristic of the instrument consists in the substitution of a half-telescope (*lunette brisée*) for the full telescope, and of counterpoises to make up for the other half of the tube. By this construction, the visual ray entering the object-glass passes to the axis of rotation, and is there reflected at a right angle, by means of a mirror placed at the point of intersection, to the eye of the observer, who is seated at one end of the axis. At the opposite end, there is a vertical circle, and the usual lamp for the illumination of the dia-

phragm. The instrument is provided with a horizontal circle, and with reading-microscopes for the determination of the azimuth and measurement of angles, with astronomical eye-pieces, and all the means required for its complete adjustment, either for terrestrial or celestial observations, and the largest size has a reversing apparatus.

By this construction, the eye of the observer remains at the same height without regard to the inclination of the telescope, and this freedom from any possible strain of the body, or of the eye, or change of position to suit the particular altitude of the star, tends to secure greater accuracy in the observations, and to make his personal error more in conformity with that to be afterward determined by the personal-equation apparatus. Another advantage consists in the omission of the long diagonal eye-piece of the usual portable transit, and the avoidance of liability, from its use, of a disturbance of the azimuth by turning it round, a motion which becomes necessary, when the pointing of the telescope is changed from a star at the north to one at the south of the zenith.

9. The objection to the *lunette brisée* is the unequal expansion of the mass of metal, and the variable inclination of the axis during the period of observation. One lamp only can be used, and, hence, one end of the axis is unduly heated; and experience has proved that, on the side occupied by the observer, the metal is expanded by the heat of his body to such a degree as to cause an elongation of the supports, and a consequent variable elevation of that end of the axis of rotation. An uncertainty in the level is essentially due to the construction.

Another objection is the reduction, below the standard required for the best field-work, of the general size of the instrument, and hence of its optical power, graduation, and illumination. This reduction is rendered necessary in order to make it strictly portable. The number of adjustments to be looked after, and the impaired light for terrestrial observations in consequence of only a partial reflection through the axis of rotation, are also objectionable, and especially in cases where the lines are long and the greatest precision required, as in the observations from which the figure and magnitude of the earth are to be deduced.

10. BINOCULAR TELESCOPES.—In the Italian group, Charles Ponti, of Venice, exhibited a portable binocular telescope. This was invented by him for the purpose of permitting the observer to use both eyes, and to obtain thereby a greater degree of light and distinctness in the observing of terrestrial or celestial objects. The improvement claimed by Ponti consists in the careful joining-together, in a parallel position, of two telescopes of equal power and length of focus; the object-glass and tube of each being square, and each tube being provided with a micrometer-screw for the adjustment of the focus. The square form permitted the eye-pieces to be brought to the same distance apart as the two eyes, and the micrometer-screw gave a means of adjusting the focus of each telescope to the vision of the observer. It is well known that, in very numerous cases, and especially with constant observers, the focus of one eye is different from that of the other.

11. PLANE-TABLE.—The instrument adopted on the continent of Europe and in the United States for the class of surveys based on triangulation, and which have in view a close delineation of the contour and incidents of the ground, whether for commercial or military purposes, is the plane-table. This instrument is too well known to require description. While, however, the general principles of its construction are the same in all cases, variations in the details and additions are made from time to time, which are claimed to partake, more or less, of the nature of improvements.

12. The most complete and highly-finished instrument of this class was found in the Russian department. It was conspicuous for an arrangement, which provided against any possible flexure of the board, or disturbance of the level, when the work and alidade were close to the edge of the board. This arrangement consisted in arranging the table to slide forward and back, so that the point on the paper at which the work was to be resumed could be placed over, or nearly over, the center of the tripod. For this purpose, there was a supplementary board, 2 feet in length, 10 inches in width, and 1¾ inches in thickness, permanently attached to the upper part of the plate receiving the leveling-screws; and upon this board or support the table rested, and could be secured to it by two wooden clamps of nearly the same length as the table, and set at right angles to the support. In the adjustment of the table, the screws of the holding-clamps were loosened so that it could be made to slide; and, when the locality on the sheet where the weight of the alidade would be most felt would be in the best position to be sustained, the screws were tightened, and the instrument became one solid structure. This plane-table was made by Stupendorff, of St. Petersburg, and is of the construction adopted in Russia for the national surveys.

13. In Group IV, of the Austrian department, Kraft & Son, of Vienna, had on exhibition an alidade, of which the pillar carrying the telescope was swung on a joint, so that both pillar and telescope could be lowered and made to lie flat and parallel with the rule. The object of this rather hazardous variation from the ordinary construction was to make the instrument more portable by reducing the size of its packing-box.

Starke & Kammerer, instrument-makers for the Austrian Polytechnic Bureau, exhibited an alidade, with a telemeter attached to and parallel with the telescope, by which the distance of the instrument from the divided staff was determined by the angle subtended by two fixed points on the staff. In other cases, the distance was obtained by observing the vertical distance on the staff subtended by a known angle or two fixed wires in the diaphragm of the telescope.

14. Japan exhibited a single surveying-instrument, and this was a plane-table. It was noticeable for the reason that it had two boards, or tables, separated by leveling-screws. The upper table was added to afford space for two wooden rollers, on which the sheet of paper could

be rolled up and secured as the topographical work and the survey advanced.

15. In Switzerland, the plane-table, as seen in actual use, was provided with a long brass clamp, similar to those employed in securing the sheet to the board, which was used for adjusting the station on the paper immediately over the station on the ground. When slipped over the board, the upper end of the clamp was made to coincide with the station on the sheet, while, from the point underneath, which was necessarily vertically under the one above, a light plummet was suspended, by means of which the adjustment was readily perfected.

16. BAROMETERS.—M. Pillischer, of London, called the special attention of the jurors to an aneroid barometer exhibited by him. The instrument was six inches in diameter. It was self-registering at certain intervals by means of electro-magnets and a break-circuit clock, and was claimed by him, from the perfection of its vacuum and of the arrangement for compensation for temperature, to be fully equal to the cistern mercurial barometer. In fact, one of the latter class, which had been compared with the standard at the Kew observatory, was placed in the same case beside the aneroid, and from repeated observations the two were found to agree very well during ordinary changes in temperature and of atmospheric pressure.

17. The aneroid must always be secondary to the cistern-barometer, and it is, therefore, only of service where the latter cannot be obtained or be carried. During a rapid reconnaissance, or in any case in which the cistern or siphon barometer would be in danger from rough transportation, the aneroid comes into play; but even then experiments have proved that, however complete the adjustments and perfect the agreement with the standard at the time of comparison near the sea-level, that agreement does not continue at any great change or difference of elevation, or even when the aneroid is brought back to the standard and to the sea-level after a season's work in the field. The results are only approximate, perhaps would be closely approximate with Pillischer's instrument, but there the advantages stop; for wherever the self-registering apparatus could be carried, the cistern-barometer could accompany it, and, hence, the combination of M. Pillischer was noticeable rather for the scientific accuracy and mechanical skill with which the registering apparatus was applied than for the value of the application.

18. Kappeler, in the Austrian group, exhibited a cistern-barometer, provided with a microscope, on which a small spirit-level was mounted; the whole being movable up and down the tube for the purpose of adjusting the scale to the height of the column, and of reading the former when so adjusted.

If similar means were employed to adjust the surface of the mercury in the cistern, which is the most difficult and certainly the most important part of the observation, there would be little chance of error beyond

that arising from the changes, which not unfrequently occur in the atmospheric conditions during the interval between the commencement and end of the operation. It may be added, however, as the result of considerable experience, that a trained and faithful observer can make the adjustments and readings, using the eye only, with all the precision required for meteorological or even hypsometrical purposes.

Previous to observing for the determination of differences of elevation, the personal error committed in the adjustment, due to a systematic peculiarity in sight and judgment on the part of each observer, should be carefully determined, and applied to the observations or their mean, as it is probable that such errors are fully equal to the combined errors from all other sources. It has been certainly found that intelligent observers, after a short practice under written instructions for each detail of the observation, rarely differ in the recorded height of the barometric column more than 0.003 of an inch, part of which is the personal error; and that the error of the mean of any lengthened series is within the probable error of the most approved co-efficients and formulæ employed in hypsometry.

19. ELECTRICAL BALANCE-THERMOMETER FOR DEEP-SEA SOUNDINGS.—C. W. Siemens, of London, exhibited an apparatus to ascertain the temperature of the ocean at any depth, based on the principle that, as the electrical resistance of any metal conductor depends on the dimensions and temperature of the latter, we have only to find the law of the increase or decrease of its resistance for high or low temperatures to be able to determine the resistance from the temperature, or the temperature from the resistance. The deep-sea thermometer, constructed by him on the above principle, consists of a "resistance-thermometer," to which the sounding-line is attached, and of a battery, electrical bridge, and "balance-thermometer," to be used on board the vessel for determining the temperature indicated by the resistance-thermometer at any point of its descent or upon its reaching the bottom. The law of increase and decrease being known, a table is made up, by means of which to correct the deviations of the galvanometer into parts of a degree of temperature.

20. The resistance-thermometer consists of a coil of fine iron wire, silk-covered, of a total resistance of 500 British-Association Units. This is contained in an inner tube of metal, the whole of which is dipped into melted paraffine-wax, so that perfect insulation is obtained. The inner tube is then inclosed in an outer tube, perforated with holes, so as to allow the free passage of water.

21. The sounding-line contains two gutta-percha insulated copper wires of equal length and resistance, served with the best hemp, and sheathed externally with copper bands. One of these wires terminates at the bottom, and is connected to the outside of the line; a good connection being made around the bottom. The second wire is connected to one end of the resistance-thermometer, the other or lower end of

which is brought out and connected to the copper sheathing to the same point at which the first line is connected.

22. The electrical bridge is the same in principle as Wheatstone's parallelogram, so generally used for the measurement of resistances; the difference consisting in merely the method of altering the resistances.

23. The balance-thermometer is constructed precisely like the resistance-thermometer, and is kept immersed in water contained in a small vessel, the temperature of which is determined by a delicate mercurial thermometer. When the two wires in the sounding-line are connected with the electrical bridge and the balance-thermometer, and when the waters surrounding the resistance and balance thermometers are of the same temperature, the needle of the galvanometer will point to zero.

24. The wires being properly connected, the resistance-thermometer is dropped overboard; the battery is connected by a key to the bridge; and the needle is immediately deflected, showing that, as the water gets cooler, the resistance of the iron decreases. The water in the vessel is then made cooler, to bring the needle back to zero, and so on, at each change of temperature shown by the galvanometer. The mercurian thermometer in the vessel and the readings of the galvanometer will give the temperature of the ocean at the depth indicated by the sounding-line at the moment of observation. For the purpose of cooling the water, the vessel referred to is provided with two tubes, one for admitting the cooling-mixture to the bottom, and the other for blowing in, so that the temperature of the water is at once rendered quite uniform.

25. The special advantages claimed for the method are, the excellence of the earth-connections, there being no polarization; the elimination of the effect of the leading wires; the immaterial ratio of increase of electrical resistance by increase of temperature; and, for the sounding-line, that while it is of no great thickness, it is of great strength, and that from its smooth and even exterior, it descends to, and can be brought up from, a depth of 2,000 fathoms in less than half the time required by the ordinary line.

The increased velocity of the descent of the line is certainly favorable to increased accuracy in deep-sea soundings, for the reason that the line would have less time to be swayed from the vertical by subaqueous currents, and that the point of suspension of the lead, which occurs when the resistance of the line and of the weight is equal to the force of gravity, would be at a greater depth. It may be added, however, that the time of suspension of the lead can never be accurately ascertained, as the line, from its own weight, would still continue to run out; and this fact has thrown doubt upon all the great depths said to have been reached. The sounding-lines lately introduced are of carbonized iron or of No. 22 piano-wire, by the adoption of which the resistance or drag has been reduced to its minimum value.

Without reference, therefore, to the invention of Prof. William P. Trowbridge, of the Coast-Survey, described in the Annual Report for 1858, by

which the resistance of the line was altogether avoided, we have only to compare the delicate and complicated apparatus of Siemens with a simple line of piano-wire and a self-registering thermometer of the most approved construction for deep-sea soundings, to come to the conclusion that the former cannot supersede the latter. This is said without intending to detract in the slightest degree from the merit of the invention and the value of the application of electrical resistances to the determination of temperatures at any distant point.

The Miller-Casella modification of Six's self-registering thermometer is said to give the temperature of the ocean-depths, within a range of 2,000 fathoms, with a degree of accuracy which, in this respect, leaves nothing further to be desired.

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I.

TELEGRAPHS AND ADMINISTRATION.

R. B. LINES.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

TELEGRAPHS

AND ON

TELEGRAPHIC ADMINISTRATION.

BY

ROBERT B. LINES,

MEMBER OF THE ARTISAN COMMISSION OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1876.

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NOTE.

Having been prevented, by continued absence in the West, from correcting the proofs of my report, I am compelled to apologize for several unfortunate errors and omissions. For instance, article 18, on page 34, was intended to describe Edison's Quadruplex, but, by mistake, a description of Edison's "Electromotograph" has been substituted, and that of the Quadruplex omitted.* Descriptions of Gray's harmonic telegraph, Sawyer's *fac-simile* apparatus, and other devices were received too late for the printer. As, however, descriptions of these and, indeed, most of the matter contained in the first chapter of the report, have already been published in the various journals devoted to the subject, the errors are perhaps more vexatious to the author than important to his readers.

ROBT. B. LINES.

CHICAGO, *April* 5, 1876.

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* See Addenda.

ERRATA.

Page 9, line 1–2, for Tommasu, read Tommasi.
Page 9, line 12, read signals per second.
Page 11, line 23, for Gurlt, read Gurtl..
Page 24, line 3, for minute, read word.
Page 30, line 33, for Linth, read Lintl.
Page 30, line 37, for Kosmota, read Kosmata.
Page 32, line 2 from bottom, for attached, read attracted.
Page 42, line 28, for Seimens, read Siemens.
Page 44, line 21, for Fichner, read Fievern.
Page 48, last line, for Lommering, read Sommering.
Page 49, line 31, for electro-, read magneto-.

TELEGRAPHS.

PART I.

CHAPTER I.

THE EXHIBITION.

IMPORTANCE AND CHARACTER OF THE EXHIBITION; INSIGNIFICANCE OF THE AMERICAN EXHIBIT; SCOPE OF THIS REPORT; MODERN METHOD OF TELEGRAPHY; CLASSIFICATION; BATTERIES; SUPPORTERS; INSULATORS; CONDUCTORS; UNDERGROUND LINES; TRANSMITTING AND RECEIVING INSTRUMENTS; JAITE'S INSTRUMENT; AUTOMATIC METHODS; LITTLE AND EDISON'S SYSTEM; MEYER'S SYSTEM; RESULTS OF TRIAL; COST; SIMULTANEOUS SYSTEMS; STEARN'S "DUPLEX;" EDISON'S SYSTEM; BAUER'S APPARATUS; PRINTING-INSTRUMENTS; MEYER'S APPARATUS; D'ARLINCOURT'S APPARATUS; GERMAN HISTORICAL COLLECTION.

1. INTRODUCTION.—The telegraph, in view of the peculiarly international character of its development, and the vast and growing importance of its relations to all affairs of government and of social and commercial life, might well claim the first rank at a world's exhibition. Scarcely thirty years old in its practical application, its processes have been multiplied and its wires extended with unprecedented rapidity, and to-day there is hardly a country on the map of the world which has not felt its benefits and contributed to its advancement. The great progress which it has made in the past few years lent an additional interest to the exhibits at Vienna, and raised expectations of their completeness which the youth of the art and the publicity which has attended its every step should have rendered it easy to gratify. In fact, the telegraphic collection at the Exhibition, although by no means complete, was still most interesting and instructive.

Not only were the leading continental manufacturers represented by well-selected specimens of their work, but many enterprising inventors appeared on their own behalf, and the principal governments, notably the Austrian, French, and German, vied with each other in exhibiting the progress which the art has made under their patronage.

2. America, however, the home of inventors in this as in other departments of industry, and the country which has furnished to the world the simplest, most practical, and to this day the most widely-used telegraphic instruments, namely, the Morse and the Hughes, and which stands, at least so far as methods of transmission are concerned, on an equal footing with others, was without a single exhibit in this group.

Brazil, Portugal, Italy, Belgium, Russia, and even Japan, were at hand with their manufactures; but America, which has laid such claims to the origin of this wonderful means of conveying intelligence, brought forward no material evidence of their justice.

A New York paper, on the 2d of May, printed three pages of telegrams on the opening of the Exhibition, transmitted over the cable for which both worlds are indebted to the energy and perseverance of an American; and the same paper contained still another page of domestic dispatches. The net results of the development of our telegraphic system were thus illustrated, while its stages and processes were left to be imagined. An American printing-telegraph was indeed catalogued but not exhibited; and a solitary specimen of insulated office-wire, classed in the group of Metal Industry, a remnant, perhaps, of our exhibit at Paris, was the only article to show that the telegraph was even known in North America. It is true that at the Paris Exposition an almost equally absolute blank existed in this department; but we had not then invited the world to visit us and see our progress in the arts and sciences at home. We certainly offered very little encouragement to the telegrapher who may have visited Vienna to come and learn of us at Philadelphia in 1876.

3. Notwithstanding the meagreness of our exhibit at Paris, however, American systems of telegraph were not neglected in the reports made by our commissioners. It would be presumption in the writer to follow the distinguished reporter on that subject in his very full discussion of the merits of the different systems of telegraphs and the priority of their invention. It will be quite sufficient, therefore, to glance only at such of the exhibits at Vienna as have been previously described, touching at greater length upon those apparatus, whether exhibited or not, which have made their appearance since the Exposition of 1867.

4. The word "telegraph," though confined in its etymological signification to a system by means of which writing may be produced at a distance, was first applied to the system of semaphoric signals in France, and has by usage become applicable to almost all means, but particularly to electrical appliances, through which signals are conveyed between widely-separated points. Such signals may be made to the eye by means of recorded characters or by agitations of a magnetic needle, or their code may be translated by the sense of sound, of touch, and, it is claimed, even of smell. The recording or "graphic" portion of Professor Morse's instrument has in fact fallen into almost complete disuse in America; all but the most unpracticed operators reading "by sound" more readily and better than "by paper," and the American "telegraph" has become really a "telephone." Just as writing from dictation is more rapid and accurate than copying from a manuscript, no matter how plain the characters, so writing from the ticking of a Morse or Bright sounder is easier than following with the eye the motion of a paper-instrument, and dividing the attention between the signals and their translation.

5. The object of all systems of telegraph is the communication of intelligence at a distance. It is clear, therefore, that a classification of apparatus, based on a strictly etymological definition of the word "telegraph," however useful in establishing claims to priority of invention, is of no logical or practical importance Such a classification would necessarily, however, apply only to the different apparatus for receiving messages. In their proper order, the component parts of a telegraph should be considered as (1) the battery, or motive power; (2) the conductor; (3) the transmitting, (4) the receiving apparatus; and (5) auxiliary appliances.

6. Batteries and sources of electricity.—In batteries, there is little to record. The ordinary forms were shown by Messrs. Siemens in handsome collections from their London and Berlin houses, together with a large number of magneto-electric instruments, or inductors, for exploding mines, for railway-signals, and other purposes, a very powerful magneto-electric machine of the "Hefner-Alteneck" pattern being shown in the Machinery Hall.

In the collective exhibit of the French telegraphic administration, which contained all the articles sent by private parties except those of M. Bréguet, were the batteries of Leclanché and Marie-Davy, so much used in France and England; also the battery of Callaud and that of Chuteau. Of these, the Leclanché and Chuteau were represented by M. Postel.

A fine collection of chemicals used in electric batteries was shown by the Messrs. Rousseau.

M. Bréguet exhibited an induction-coil with a polarized armature, by depressing which, signals were sent through a resistance equal to four hundred miles of line. A more powerful instrument of this class for the purpose of exploding mines was also shown; a large magnet composed of laminæ of steel joined together in the ordinary horseshoe shape, and which, weighing 50 kilograms, sustained a weight of 500, was shown by M. Bréguet as the invention of M. Jamin. M. Jamin claims, and the magnet exhibited seemed to support his assertion, that he has discovered a means by which a magnet of any required sustaining power may be produced; in other words, that he has discovered the law of increase and diminution in the attractive power of magnets, and that, up to a certain point, it can be regulated by adding to the number of steel laminæ. A paper read by him at the meeting of the *Académie des Sciences* on the 12th of May, 1873, has been furnished by M. Bréguet, but is too long for incorporation in this report. The discovery, although important, will be principally of use in the manufacture of magneto-electric machines, which are employed to a limited extent only in the transmission of signals. The magneto-electric machine of Gramme was also on exhibition by M. Bréguet.

In the historical collection of Germany, which will be touched upon specially, were also specimens of magneto-electric apparatus.

The Austrian administration exhibited the Meidinger, an excellent constant battery which is used in Vienna and generally throughout the empire, the Daniell, and a field-battery of the Marie-Davy pattern.

Dr. Werner Siemens, the eminent electrician of Berlin, being vice-president of the jury on Group XIV, the articles exhibited by his firm were out of competition, as were also those exhibited by M. Bréguet, that gentleman being a member of the same jury.

7. SUPPORTS, INSULATORS, AND CONDUCTORS.—In this department of telegraphy, there is also but little improvement since the latest reports. Iron posts, constructed in vertical halves, which were bolted together, were shown both by the Messrs. Siemens and by the French administration. There were no specimens, so far as I could ascertain, of wooden poles prepared with creosote or sulphate of copper, which are used to some extent on the continental lines. The porcelain insulators, common on the continent, were shown in all the departments. Siemens also displayed his own pattern, the Varley, used principally in England, and the Brooks paraffine from Philadelphia, which has obtained a foothold in several foreign countries.

Of simple conductors, there were very few specimens in the telegraphic section, the great English manufacturers not being represented. Siemens and a few other European firms showed samples of insulated office-wire, as also did Austin F. Day, of New York, of his kerite-covered wire which has already been described by Professor Morse, and which formed, as I have stated, the only telegraphic exhibit directly from America. The place of American compound wire, which has given such good results in the limited field to which it has been applied, was taken by a steel and copper wire, of almost exactly similar make, in the Siemens English department.

Of sea-cables exhibited, the specimens of the Messrs. Hooper, of Silvertown, and of the Indo-European Company, were the most complete. There has been little or no change in their composition since the transatlantic cables of 1865 and 1866, which were honored by a Grand Diploma, specially awarded at Paris, an award granted, however, less on account of their merits *per se* than as a recognition of the energy and earnest purpose of their promoters, and one, therefore, in which America may claim a proud share. The immense growth of submarine telegraphy since that day is a subject on which much might be written, which, in another place, would be appropriate. In the matter of cable-construction, however, the only change of importance has been the substitution of the French cable of the Bright and Clark compound, formed of tar and pulverized silex, in the place of the well-known Chatterton mixture. The Messrs. Siemens, in their English department, showed a specimen of the new German cable, which is now on its way to its landing in New Hampshire, and samples of gutta-percha in all stages of manufacture. The Telegraph Construction and Maintenance Company, the largest manufacturer of cables, was conspicuous by its absence. A new form

of cable, which has been elsewhere described, the invention of M. Tommasu, was also on exhibition. It consists of a tube or a number of tubes of pure copper, of from two to three millimeters in diameter, insulated, and bound together in a cable covered on the outside sufficiently to prevent corrosion. These tubes are to be filled with water, and, by pressure from the ends, the column is to be moved back and forth a distance of one millimeter, a drop of mercury at the receiving end moving with it, and closing a local Morse circuit. It is claimed that a cable of this description would cost much less than the expensively manufactured ones now in use, and that the column of water may be moved back and forth with a pressure of six hundred grammes at a rate sufficient to produce ten signals, or an average of twenty words a minute, in the European dot-and-dash code. The French government has shown sufficient confidence in the invention to authorize a cable of this kind to be constructed and laid between Corsica and the main-land.

8. UNDERGROUND LINES.—The system of underground cables used in the larger cities is shown by the French administration. It is stated by Culley and by many other electricians that in large towns, especially manufacturing centers, it is better, not only from the stand-point of the public convenience but from the opposite one of interest, which is sometimes occupied by those in control of the telegraph when it is not a governmental institution, to use underground wires, as the insulation is much better, and no trouble need be apprehended from inductive currents, as on longer lengths. A short description of the French system may therefore be not without interest.

The conductor, formed of a wire-cord of four strands, spirally twisted, is covered with a sheath of gutta-percha of about five millimeters in diameter, and surrounded by a covering of cotton saturated with wood-tar, and another not so saturated. These envelopes of cotton are dipped in sulphate of copper solution. The cables contain from three to seven conducting-wires, according to the needs of the service. They are laid in cast-iron pipes similar to those used for gas, 2½ meters in length, and of a size proportioned to the number of cables. The lengths of pipe are united by leaden rings; every 50 meters there is a joint of larger diameter, which slides over its neighbors like a sleeve. At the moment of laying the pipes in the trench dug to receive them, a thread is passed through the pipe, which, at the adjustment of each length of 200 meters, introduces a larger cord; one of the ends of this cord is rolled upon a winch, and the other attached to a small iron bar mounted with "gudgeons," which hold the cables to be inserted. The cable is thus drawn through the pipe, passing first over a pulley whose horizontal tangent is in a line with the pipe. If the joints are well made, the pipe is weather-proof, and the cable is sheltered from all infiltrations of water or of gas. The use of the larger joints of pipe above mentioned makes the repair of the cables in case of accident an easy matter.

9. TRANSMITTING AND RECEIVING INSTRUMENTS.—Having rejected

the classification of instruments according to the accident of their leaving a record or not, the properties of the electric current made use of for the production of signals might, perhaps, be taken as a basis for division, and a first class be formed, styled the magnetic, and made to embrace the Morse, the Hughes, and all printing-systems, as well as the needle-telegraphs; while to the second class, called the electrolytic, or chemical, should be referred the Bain, the automatic or fast system, and most of the *fac-simile* or copying instruments. The first class might again be subdivided accordingly as the current is used to effect the movement of a simple iron armature, or to deflect an already magnetized needle. When, however, we consider that in telegraphy similar objects are often attained by widely differing means, and dissimilar results produced by the same property of the current, even this classification seems vague and unsatisfactory.

A simpler grouping, and one which will appeal more readily to the untechnical sense, would place in one category, systems actually or necessarily employing a code for translation either by the eye or ear, messages transmitted by which would appear in the handwriting of an operator; in another, those conveying their messages to the eye of the addressee in printed characters; and in a third, the few by which the handwriting of the sender himself is transmitted to his correspondent, making the message, in fact, an open telegraphic letter. Of the former class, the Morse system appeared at Vienna in all its shapes except in the one best known in this country, *i. e.*, the sounder, an almost exclusively American institution.

10. The ink-writer, which has been generally substituted in Europe for the embossing or "*pointe seche*" register—the Siemens pattern being generally considered the best—was the most common of all exhibits. The different houses represented in the French department, especially that of Digney Fréres, exhibited a number of Morse instruments. A number of "*soneries*," or signal-bells for railways, were also shown. Messrs. Digney showed an electric whistle, to be attached to a locomotive, and sounded by a contact made by a wire-brush with a sheet of brass placed between the rails. Messrs. Siemens also exhibited in their English and German departments their old form of station alarm-bells and their new magneto-electric block-system, none of which come within the range of this report.

In needle and alphabetical dial or pointer instruments, there was nothing worthy of note, unless it be the exhibition of one in the Japanese department.

A new instrument of Hefner-Alteneck, shown in Mr. Siemens's collection in the German section, was composed of a transmitting-apparatus with forty-nine keys in seven banks of seven keys each, properly lettered and arranged so as to produce the signals of the Morse code at a single touch. By an ingenious contrivance, each key displaces a certain number of pins, corresponding to the letter which it indicates, (a single pin

producing a dot, three consecutive pins a dash, and three following each other in the order of 1, 3, 5, three dots, or the letter S.) These pins are on the periphery of a drum or wheel, moved by clock-work, and being displaced, close the electric circuit, after doing which they are automatically returned to their places. The receiving-apparatus consists of the ordinary Morse ink-writer, the transmitter occupying the place of the key. A gain in accuracy, over signals produced by hand, is of course obtained after the operator has become accustomed to the use of the key-board; and the Morse code in use in Europe being much longer than that employed in this country, there is a considerable increase of speed. It is claimed that an expert operator can touch three hundred letters a minute, or, at an average of six letters per word, about three thousand words per hour, which is the ordinary speed of the American "combination" printing-instrument, and more than double that of the European Morse operator, and a large increase upon that of the practised American operator, and the European Hughes. It may be doubted, however, whether the arrangement of keys in banks instead of consecutively, as with the combination instrument, will allow of such speed. At any rate, the cost of the transmitter will probably prevent its being substituted to any extent for the inexpensive Morse key. The work produced cannot, of course, be compared in accuracy or convenience with that of the Hughes combination or other printing-instruments.

11. Mr. W. Gurlt, of Berlin, exhibited in the German department a telegraph embracing some new and useful points, the invention of Mr. Jaite, of that city, who has also devised, and put into operation, a system of "repeaters" for the Hughes printer. A general view of the instrument is given herewith in Fig. 1. To show its detailed operation would require a series of ten or twelve plates and a correspondingly long explanation. I shall endeavor to give, as briefly as possible, a general idea of its workings, and for a more minute description refer the reader to the "*Annales de la Télégraphie,*" published by Dr. Brix, (Berlin, 1872,) or to the *Journal télégraphique* for September and October, 1874. Mr. Jaite's main object has been to avoid the loss of time caused by the use of the dash in the Morse code, as well as the difficulty which it occasions in repeating or transferring writing from one circuit to another. In the accomplishment of this purpose, which will appear of less importance, perhaps, to the American than to the European telegrapher, he has availed himself of appliances which may be turned possibly to good account in other directions. In dispensing with the dash, Mr. Jaite adopts an alphabet, some letters of which appear on the strip shown in the figure, composed of dots perforated through the paper in two lines, as in the Steinheil alphabet, and very much as in the transmitting-strips of the American automatic system, with the exception that the dots in each line are, in the Jaite instrument, of equal size. His system also differs from the automatic essentially in this, that the *punching* is done simultaneously at both ends of the line *by the action of*

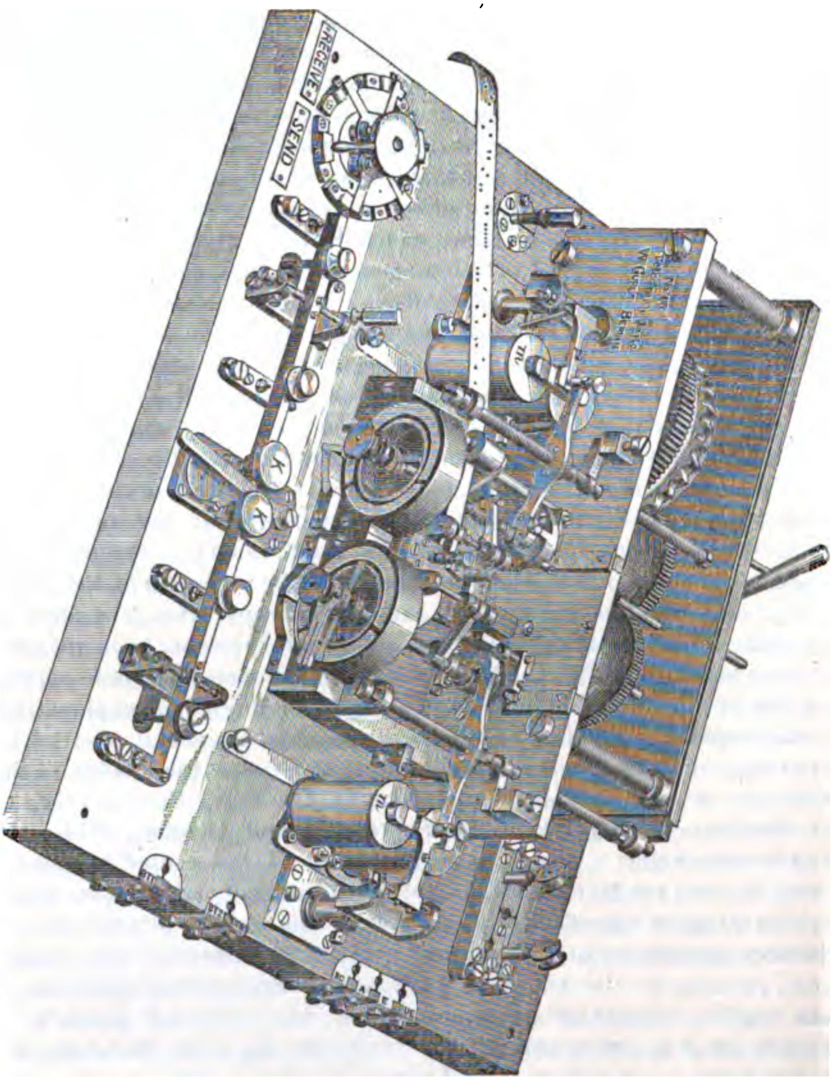


FIG. 1.—Jaite's Instrument.

the current, the perforated strips being the record at the receiving-end, and only used for transmission, for the purpose of repetition, verification, or in case two or more copies are perforated for duplication upon other wires.

The two keys K K′ transmit, one a positive and the other a negative current; the polarized magnets *m m′* of the receiving apparatus are wound in opposite directions, so that a current which would add to the attractive force of *m* would cause *m′* to repel its armature and *vice versa.* A positive current being sent through *m*, we will say, neutralizes its attraction and repels its armature-lever, the other end of which releases a chain of clock-work moved by a weight, and brings into quick operation a punch, which perforates the lower line of the strip, forming the letter E. The flow of the current ceasing, the magnet re-attracts the armature and arrests the clock-work. A touch of *k′* acts similarly upon the magnet *m′*, whose armature-lever in its turn sets in motion a punch which perforates the lower edge of the strip, making the letter N, in Mr. Jaite's code. Pressing the keys in succession forms the letter *:* S or *:* T, according to which one is first touched. The clock-work is wound up by a key, such as is used on the Morse register. A "repeater" arrangement, easily understood, is comprised in the instrument. This apparatus was tried between the Bourse of Berlin and that of Hamburg for several consecutive days in February, 1872, and gave an average of fifty-six messages per hour, to each of which the signal of acknowledgment was given. The maximum in any one hour was eighty-five messages, and the average for the first two days sixty-five.

12. The fact that under favorable circumstances from twenty thousand to thirty thousand distinct pulsations can be transmitted over a wire in the space of a minute, and recorded either chemically or by the action of delicate magnets, while the hand of an operator is unable to produce by such contrivances as the one above described more than from twelve hundred to twenty-four hundred, has led inventors to attempt the utilization of the highest possible number of pulsations. Two modes of accomplishing this have suggested themselves, the first of which involves the preparation of messages by composition in the form of type, arranged to produce the spaced alphabet of Morse, or by the perforation of paper strips, with letters of the same, and their subsequent automatic transmission over the wire. In this system, but one instrument is used at each end of the line, and worked at a high rate of speed. In the other method as many instruments as may be necessary to attain the capacity of the wire are attached to its termini, and arranged so that each transmitter and its corresponding receiver shall have control of the circuit at regular intervals; the intervals being long enough for the production of one or more signals, and occurring frequently enough to enable the operator to transmit as many signals per minute as with the ordinary instruments.

Of the former class, commonly known as "automatic" instruments,

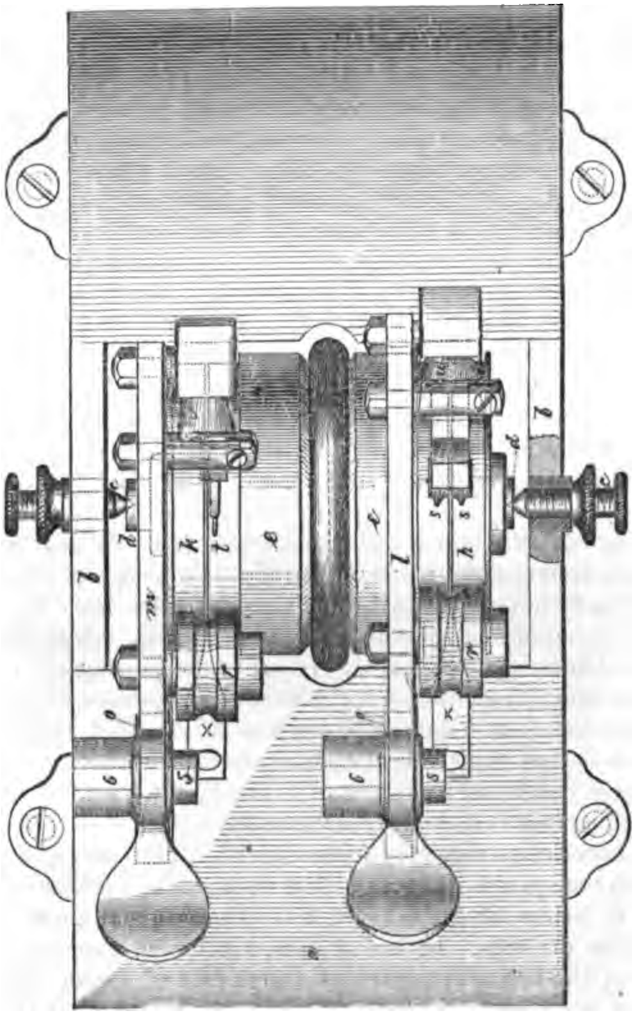


FIG. 2.—The automatic telegraph.

there was exhibited at Vienna the Siemens punched-paper apparatus, together with a punching-machine, in the excellent style of workmanship characterizing all manufactures of that house. These have been previously described and commented on in Professor Morse's report. The Siemens prepared-type process was not exhibited; but there was an exceedingly crude instrument of that kind in the Italian department, together with a punched-paper instrument of M. Sacco, also the Schneider process in the Hungarian department.

The Wheatstone punched-paper process, used quite extensively in England, was also not on exhibition. While in London, however, the writer saw the operation of this instrument, and was told that its maximum speed was seventy-five words per minute. Its operation has been often described.

13. The most important instrument of this class is the American automatic, known as the Little system, with modifications, of which a description (taken from the patent specifications of Messrs. Little and Edison) is given herewith.

The perforator, being a purely mechanical contrivance and quite complicated, is not described.

"This instrument is adapted to sending pulsations by perforated paper, or receiving messages upon chemical paper, in the automatic system of telegraphing, and is designed more especially for local or branch offices.

"A roller is made with two grooves or drums for strips of paper; one grooved drum is for the perforated transmitting-strip, and the other is for the chemical receiving-strip. Two hinged levers are provided, each with a pressure-spring, contact-roller, and guiding-brush, and one has the transmitting stylus or rollers, the other the recording stylus or pen. One of these levers is lifted when the other is depressed, and the circuit-connections are to the drum that is insulated and to the frame carrying the levers, so that whichever lever and stylus is depressed will be operative.

"This instrument is strong, cheap, and compact.

"In the drawing, Fig. 2 is a plan of the instrument, with the frame partially in section; and Fig. 3 is a side-elevation, also partially in section.

"The frame of the machine is made hollow, with inclined ends, *a a*, and vertical sides, *b b*. Through these sides *b b* are the insulated center-screws *c*, sustaining the shaft *d* of the roller *e*, that may be of wood, metal, or other material, and contains a groove to receive a belt leading to a pulley or other convenient source of motive power, such as a hand-crank, fly-wheel, and treadle. The two grooves *h* and *k* form drums for the strips of paper, and levers, *l m*, are made each with a spring, *o*, to press the lever toward the drum or to hold up the same, when turned back sufficiently for the spring to enter the notch 3, each lever being attached by a fulcrum-screw, 5, to the standard, 6. Upon

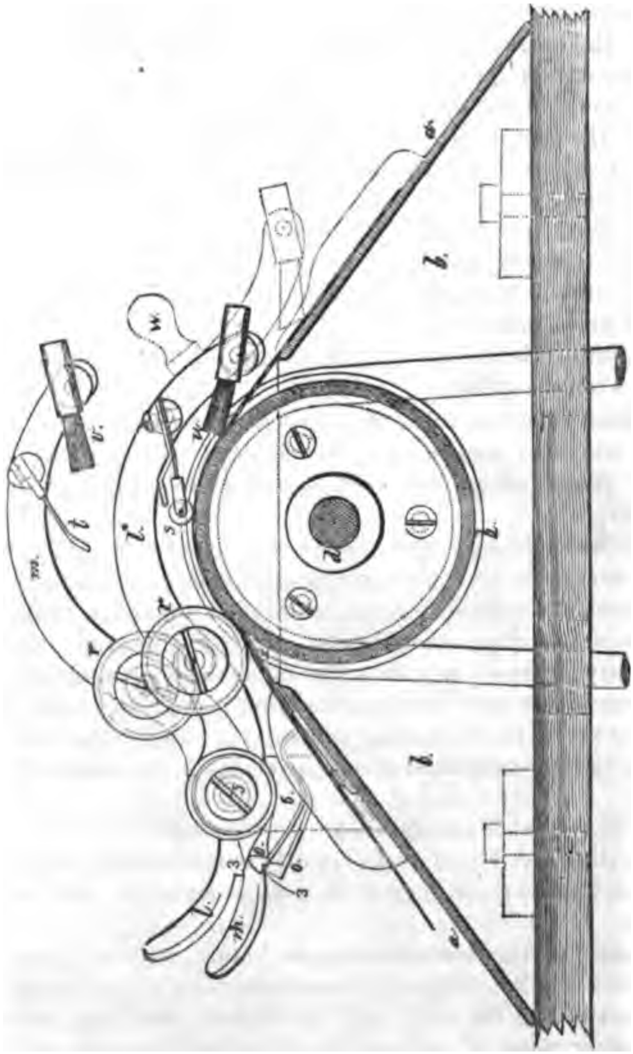


FIG. 3.—The automatic telegraph.

each lever is a roller, *r*, that serves to press the strip of paper to the drum, and insures the drawing of the same along when the drum is revolved. The lever *l* is provided with a transmitting stylus or roller, *s*, upon a spring-arm. This arm is attached to the lever by a nut, so as to be adjustable. There may be one, two, or more of the rollers *s*. The lever *m* is provided with a stylus, *t*, for receiving and recording messages in connection with chemical paper. It is upon the end of a spring-arm connected to a clamp that is bolted adjustably to the lever *m*. Each lever, *l m*, carries a brush or yielding detainer, *u v*, of any suitable material, to straighten the paper and insure its proper contact with the surface of the drum. These brushes or detainers either act against the paper as it is upon the drum in the groove thereof, or else against the paper while in a trough cast in or attached to the inclined ends of the frame *a*, in which case the brushes *u v* will be positioned as shown by dotted lines in Fig. 3. If the roller *e* is made of metal the screw *c* should pass through insulated bearings, so that one wire can be attached to said screw *c*, and the other to the bed *a b*; but if the drums *h k* are insulated from the shaft, the connection may be made through insulated springs bearing against the surface of such drums. In either case, the electric current will pass by the bed *a b* through whichever lever, *l* or *m*, may be turned down for operation; thence by the stylus *s* or *t* to the drum and its electric connections to the rheostat, line-wire, battery, condenser, or earth-connection. The drums *h k* may be of cast iron or other metal, plated, if desired, with nickel or other metal that can easily be kept clean. The drums *h k* may each be upon a short shaft, with a pulley of non-conducting material between them for the purpose of insulating the drums from each other, and to connect the drums to the pulley upon the same axial line. One end of each shaft may pass a short distance into said pulley, and be secured so that the drums and pulley will revolve together. The strip of paper is easily introduced or removed by raising the lever and parts carried by it, and the lever that is not in use remains elevated. A handle may be provided for each lever *l m*, as shown at *w* by dotted lines. A clearing-finger, *x*, insulated and entering a groove in the drum, is employed to insure the delivery of the paper. The sides of the standards 6 next the paper should be rounded, or sufficiently distant not to touch the paper. The trough for the strip of chemical paper, if cast with the end *a*, should be lined with mica for the paper to move over to prevent discoloration of the paper by contact with the metal of the trough.

"Fig. 4 shows the arrangement of circuits in one of the modes devised by Edison.

"*a* is the transmitting-instrument, in which the strip of perforated paper is employed to make and break the circuit; *b* is the receiving-instrument for the strip of chemical paper; *c* is the main line; *d*, the main battery; *e e*, the ground-connections; *f* is a branch circuit to the earth, in which induction-coils or magnets, *g*, are introduced; *h* are the

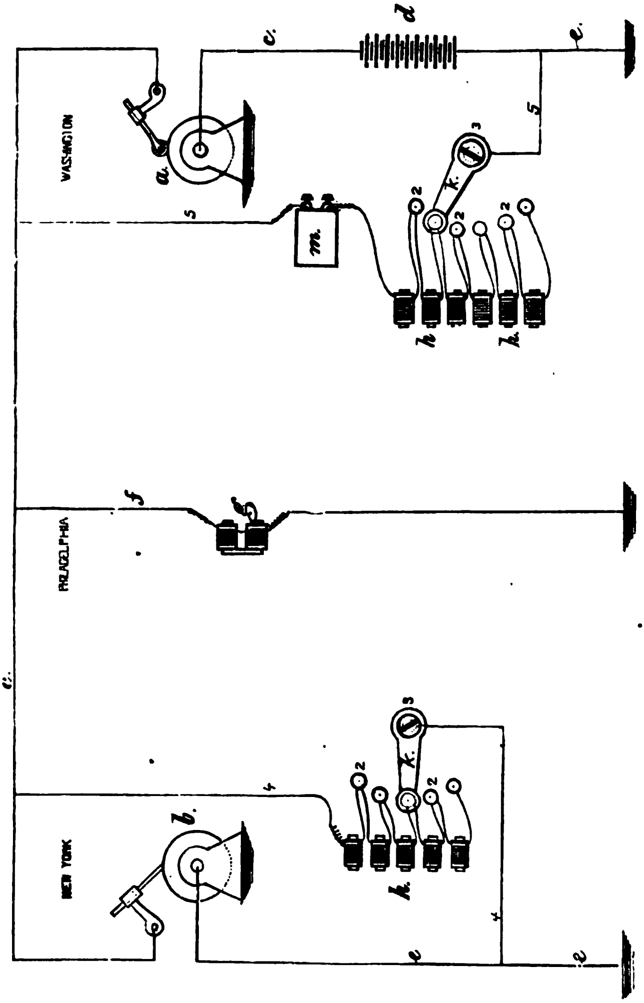


FIG. 4. Edison's form of circuit.

induction-coils at the receiving-station, employed in a shunt or derived circuit to neutralize the attenuations of the pulsations in the main circuit, and prevent the tailing upon the chemical paper. They are connected together through the contact-pins 2 2, and these are arranged in the arc of a circle, of which the fulcrum 3 of the switch *k* is the center, and to this center 3 one of the shunt-wires, 4, connects. By moving this switch *k*, one or more of the helices is placed in the shunt-circuit, and the reactionary effect in clearing the line or instrument of tailing is thereby increased or decreased, as required.

"At the transmitting-station, the shunt circuit 5 is provided with the resistance or rheostat *m*, and the electro-magnets or induction-coils *h*, switch *k*, and contact-pins 2 2, so that there may be more or less reactionary effect of the helices *h* to cut off the tailings upon the main line, because, when the circuit is closed at the transmitting-instrument *a*, a large portion of the battery-power passes through the shunt 5, switch *k*, coils *h*, and rheostat, and there is an accumulation of energy in the helices *h*, and as soon as the circuit through the instrument *a* is broken, the magnets *h* discharge themselves with more or less power, according to the number of said helices that are brought into the circuit; and this discharge, being in an opposite direction to the current of the battery, acts to clear the line of any surplus or static electricity, and prevent tailing.

"It will be evident that the reactionary effect of the induction-coil or magnets in the shunt-circuit at the transmitting-station is to neutralize static electricity, or to bring the line to a normal electric condition instantly, thereby greatly promoting the rapidity of action.

"Either the positive or the negative of the transmitting battery may be to the line, and the other pole to the earth; but the connections of the receiving-instrument must be made accordingly."

The following is taken from an account of a test of the above instrument, at which the writer was present by invitation of the Automatic Company, and presents a fair statement of its speed and cost as compared with the Morse system.

"OFFICE OF THE AUTOMATIC TELEGRAPH COMPANY,
"*New York, January* 28, 1874.

"The president of the Western Union Company having set forth, in a published letter to the Postmaster-General, under date of December 27, 1873, concerning the automatic or fast system—

"1st. That the automatic system is slower than the Morse;

"2d. That it requires five times as many operators;

"3d. That consequently it is more expensive—

"The Automatic Company determined to test the accuracy of these statements by a public demonstration over their line of one wire between Washington and New York.

"The trial took place on the evening of the 27th instant.

"By invitation, the electrician of the Western Union Company, Mr. George B. Prescott, was present in New York, and Mr. Whitney, manager of the Western Union Office, Washington, D. C., was at that end. In addition, there were present in the New York office, Hon. Hiram Barney, General J. H. Wilson, H. G. Pearson, assistant postmaster, and Mr. Hinchman, also of the Post-Office Department, New York, J. G. Smith, general superintendent of the Franklin Telegraph Company, and several others; and, in the Washington office, Mr. Lines, of the Post-Office Department, and Captain Howgate, United States Signal-Corps, and others.

"The matter transmitted was the President's late message, with the Spanish protocol attached, numbering 11,130 words; it having been selected in consequence of the declaration that its transmission over eight wires by the Western Union Company on December 2, 1873, in 70 minutes, was a feat unparalleled in telegraphy.

"The work commenced in Washington at 5.39 p. m. The document was copied complete in New York at 6.48 p. m., occupying in all but 69 minutes, as against 70 minutes, the time consumed by the Western Union Company. The average time was 55½ minutes, as against 59 minutes by the Western Union Company.

"The Automatic used but one wire; the Western Union Company used eight.

"The Automatic used ten perforators, thirteen copyists, and two Morse operators, as against sixteen expert Morse operators by the Western Union; the average pay of perforators and copyists being $40 per month. All of which details are shown in the accompanying report.

"In the demonstrations made, let it be borne in mind that on the one side the work was done by the ablest experts in the world, and a company with years of experience. On the other side, except the Morse operators necessary to manipulate the wire, our force had not that experience which is requisite for expertness."

"GENERAL OFFICE OF THE
"AUTOMATIC TELEGRAPH COMPANY,
66 *Broadway, New York, January* 28, 1874.

"Hon. GEORGE HARRINGTON, *President:*

"SIR: I respectfully submit the following report of the work done in the demonstration made on Tuesday evening, January 27, as per your instructions of prior date. The matter selected for the purpose was the President's late message and the Spanish protocol.

"STATEMENT.

"Matter transmitted	11,130 words.
"Length of circuit	281 miles.
"Conductors used	1 wire.

"*Labor.*

"New York...	Morse operator	1		Total, 25 operatives.
	Copying operatives	13		
"Washington.	Morse operator	1		
	Perforating operatives	10		

"*Time.*

		p. m.	mins.	
"Washington.	Perforating commenced	5.39	$45\frac{1}{2}$	Total time, 69 minutes.
	Perforating completed	$6.24\frac{1}{2}$		
"New York...	Copying commenced	5.42	66	
	Copying completed	6.48		

"*Cost.*

"Morse operators .... $100 per month.
"Automatic operatives .... 40 per month.

"The characters were perfectly legible and well defined, and were copied with great facility.

"The average time during which the perforating operatives were actually at work was $45\frac{1}{2}$ minutes, making an average per operative, per minute, of 25 words.

"The average time of copyists was 50 minutes, making an average per copyist, per minute, of 17 words.

"Unlike the Western Union Company, we had no large corps of operators from which to select our working force, but were compelled to utilize *all*, good, bad, and indifferent, which makes it proper to call special attention to the above averages made.

"The whole time consumed was 69 minutes, as against the published record of 70 minutes by the Western Union in their late effort.

"The average time occupied by Automatic was $55\frac{1}{2}$ minutes.

"The average time occupied by Western Union (as reported) was 59 minutes.

"An unfortunate defect in the paper caused much delay in the transmission, otherwise still less time would have been consumed. No attempt, however, was made to attain a high speed of transmission on this occasion, as that point had already been yielded and incontestably proved in the presence of the Hon. John A. J. Creswell, Postmaster-General, and numerous other gentlemen, including Senators and Representatives in Congress, on the evening of December 11, 1873, when we transmitted some 12,000 words over our one wire from Washington to New York in $22\frac{1}{2}$ minutes.

"Our operatives were congregated at Washington and New York on Monday, January 26, and were tested for the first time on the evening of that day. I call attention to this, in anticipation of the charge that

the time which has elapsed since the publishing of the message has been improved by our operatives in practicing upon it.

"With the experience gained in this demonstration, I am confident that in another we could readily dispense with at least two perforators and three copyists, and yet perform a like amount of work.

"Respectfully,

"E. H. JOHNSON,

"*General Manager.*"

It would seem from this that the automatic instrument has a brilliant future before it, as its ability is shown to handle the same amount of business with two-thirds the working cost of the Morse system, and to save a capital expense of seven wires in eight. If the question were, which of the two systems should be primarily adopted, it would undoubtedly be decided in favor of the automatic. Again, if the wires in this country were under the control of the Government, seeking not to make a profit from telegraphing, but to bring dispatches to the lowest paying rates, it could be used with the greatest advantage to provide for the increase of traffic which would follow from a reduction of the tariff. In point of fact, however, the wires are virtually controlled by a company with a very large nominal capital, on which dividends are demanded.

According to Sir James Anderson, who has investigated this subject thoroughly, sudden and large reductions in tariff are always followed by a diminution in net profits. The wires now standing are sufficient for the ordinary increase of business, especially with the use of the improved Morse instruments. A company using the automatic would make little headway against the present monopoly: first, because the time occupied by the dispatch between the sender and the receiver, which is the only question aside from the price, is no less than by the Morse system when the wires of the latter are working well; and, second, because to control business its lines must reach all points, paying or non-paying. No capital likely to be invested can wait for its returns until such an extension is completed. It will be some time, therefore before the benefits to be derived from the employment of the automatic system can be realized, at least in this country, unless the wires are put under the control of the Government.

14. A system which seems to promise as good results as the automatic, if as successful in the actual workings as it appeared to be at the Exhibition, is that of M. Meyer, an employé of the French *Administration des Télégraphes*, in whose collection the apparatus was shown. It operates in the second of the methods before mentioned, dividing the control of the circuit between a number of instruments, each being given an interval of time in which to produce signals. A description of the apparatus on exhibition at Vienna, as translated from the "*Journal télégraphique*," is given below. It is arranged for four operators, revolves at the rate of seventy-five turns per minute, each of the four

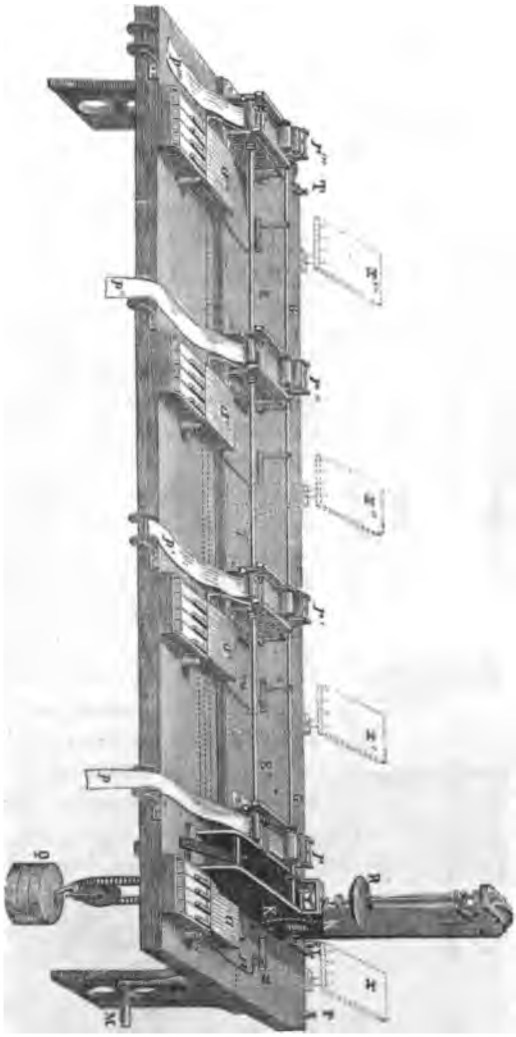


FIG. 5.– Meyer's system.

transmitters being able to make one letter at every revolution. At this rate, twelve hundred emissions of the current are made use of per minute, which, at the rate of twenty emissions per minute, would give sixty words, or thirty-six hundred per hour. The speed of manipulation could doubtless be increased, or the number of available emissions up to twenty thousand per minute could be used to increase the number of instruments. Fig. 5 gives a general view of the apparatus. Upon a table about ten feet in length are placed four small key-boards, a, a', a'', a''', each having its band of paper, p, p', p'', p''', and their receivers, r, r', r'', r'''. The printing-apparatus is a quarter spiral, which rubs against an ink-roller. A single piece of clockwork, moved by a weight and regulated by a conical pendulum with fixed suspension, moves the receivers with the aid of the two axial rods, G, G′, and E, E′. The first turns the helices and the second unrolls the paper. The key-boards as well as the receivers are connected electrically on one side with the ground and on the other with the line-wire by means of the distributor K, (Fig. 6.) A single battery suffices for all the transmissions. The distributor K is the characteristic portion of the multiple telegraph. It is that which in four equal intervals of time directs the current from the battery successively toward each of the four receivers of the transmitting-station, and thence to the receivers at the receiving end; for each dispatch is written at the same time at both ends of the line. O O′ is a disk of metal fixed and insulated. It is divided into forty-eight parts, twelve for each quarter-circle, of which eight, grouped two by two, are connected by a cable of eight insulated wires to the eight keys of the key-board. The other four are connected permanently with the ground. There are therefore four cables of eight wires each connecting the four key-boards to the dis-

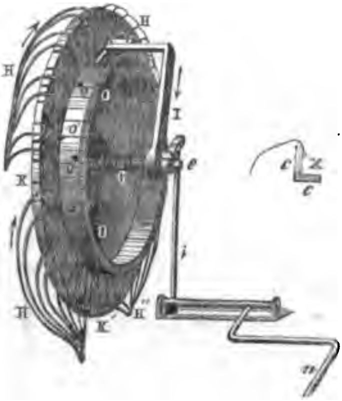


FIG. 6.—Transmission—Meyer's system.

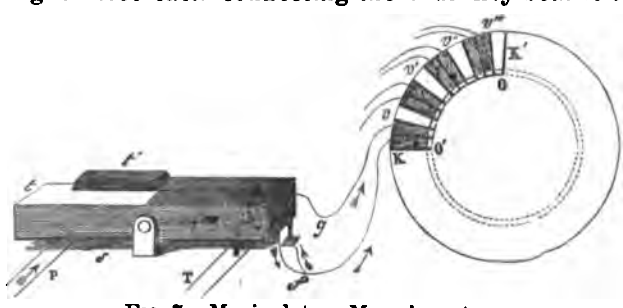


FIG. 7.—Manipulator—Meyer's system.

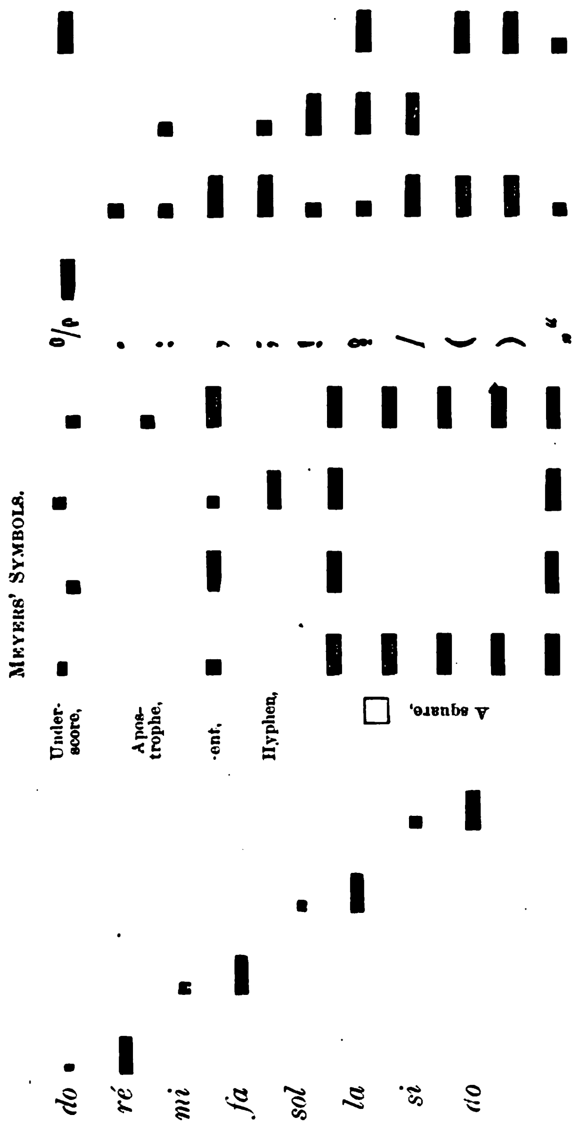
tributor. The groups, or double divisions, thus number sixteen, separated by spaces, four for each quarter-circle. The first half of the

MEYER'S ALPHABET.

a	▪	▬		
â	▪	▬		
b	▬	▪	▪	▪
c	▬	▪	▬	▪
d	▬	▪		
e	▪			
é	▪			▪
ê	▪		▪	▪
f	▪	▪	▬	▪
g	▬	▬	▪	
h	▪	▪	▪	▪
i	▪	▪		
î	▪	▪		▪
j	▪	▬	▬	▬

k	▬	▪	▬	
l	▪	▬	▪	▪
m	▬	▬		
n	▬	▪		
o	▬	▬	▬	
p̂	▬	▬	▬	▪
p	▪	▬	▬	▪
q	▬	▬	▪	▬
r	▪	▬	▪	
s	▪	▪	▪	
t	▬			
u	▪	▪	▬	
û	▪		▬	▪
v	▪	▪	▪	▬
w	▪	▬	▬	

x	▬	▪	▪	▬
y	▬	▪	▬	▬
z	▬	▬	▪	▪
ch	▬	▬	▬	▬
1			▪	▬
2		▪	▪	▬
3		▬	▬	▬
4			▬	▬
5			▪	▪
6		▪	▪	▪
7		▬	▪	▬
8		▬	▪	▪
9			▬	▪
0				▬



Meyers' Symbols.
Under-score,
Apos-trophe,
-ent,
Hyphen,
A square,
do
ré
mi
fa
sol
la
si
do

group, $\frac{1}{48}$ of a revolution, gives a brief contact; the entire group, a contact twice as long. A metal spring, *u*, mounted on the arbor G G′, traverses the circumference of the disk and places the four key-boards and receivers successively in connection with the line, so that every current emitted or received through the passage of the piece of metal *u* over one of the quarters of the circle passes through the receiver which corresponds to it. Each employé has thus the line at his disposition during a quarter revolution. A section of the manipulator is shown at Fig. 7. On pushing down the black key, the current passes into the first section of the group, while pressing the white key sends it into both sections of the group. The first touch, therefore, gives a short emission of the current, or a dot; the second, a longer emission, or a dash. The alphabet thus composed, which is given below, somewhat resembles the Morse code.

To transmit a letter, as many keys, white or black, are touched as the letter contains dots and dashes, care being had to commence invariably at the left of the key-board to produce letters, and at the right to produce figures, and to hold the key down during the entire revolution of the disk. A signal gives notice when the letter is completed. For this purpose, there is an eccentric on the axial rod G G′ in front of each of the four key-boards, whose function is to raise, after each letter, a small hammer, which falling back by its own weight produces a slight noise, and "beats the time" for the operator. The eye need not, therefore, be fixed upon the key-board. Fig. 8 represents the receiver, which

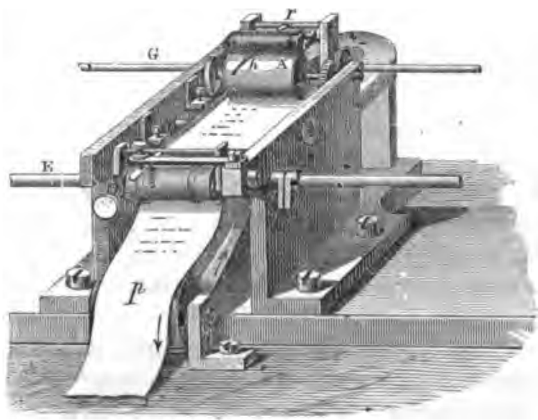


FIG. 8.—Receiver—Meyer's system.

has for printing a spiral, *h*, of one-quarter circumference, the apparatus being for four transmissions. The spiral of the receiver, and the frotteur, or rubber, on the distributing disk, revolve in the same time, the latter pausing over the first quarter of the circle while the first spiral passes over the paper strip, and so on with the others. An inking-roller presses against each of the helices. Under them are continually unrolling, at the rate of about four millimeters per revolution, four end-

less bands of paper, each passing over and adhering closely to the surface of a frame carried by a lever attached to an electro-magnet. The band of paper follows the oscillations of the lever, whose play is limited to one-tenth of a millimeter. The letters are printed from left to right, following each other in a transverse order. This arrangement of the letters avoids all confusion, or "running together," and reduces considerably the length of paper necessary. Words are separated from each other by passing one or two turns of the roller without printing. The lever oscillating beneath the paper carries on its farther end a smal electro-magnet, whose bar serves as an armature to an artificial magnet. The current produces repulsion of the armature, and therefore successive oscillations of the lever. The band of paper follows these oscillations, and, striking against the spiral, receives ink-impressions from it, equal in length to the length of the transmission.

The multiple instrument requires, as will be readily seen, synchronism between the apparatus at each end. To accomplish this, a conic pendulum of fixed suspension, a heavy ball attached to an elastic cord, controls the movements of the clock-work. This regulation alone would be insufficient, although from one revolution to another there is scarcely a loss of a thousandth of a second; a system of correction is therefore made use of to compensate these variations by means of raising or lowering the ball of the pendulum through the action of the current.

At each turn of the helix, a current is emitted, by the effect of which the revolution of the receiver is accelerated or retarded. The ball of the pendulum, which slides with little friction on the rod, is suspended by a double spiral spring of determined elasticity, in order to render as easy as possible the vertical displacement of the ball. One end of a cord is attached to the ball, and the other end to a winch. As this winch turns in one direction or another, the cord winds or unwinds, and the pendulum-ball rises or falls, and the speed of the receiver is increased or diminished. The arbor which carries the winch has a disk at its lower end, subject to the attraction of an electro-magnet. Two cams, fixed upon two wheels turning in opposite directions, act alternately upon the disk at each revolution, the one pushing it up and the other down.

By the aid of this double effect, the synchronism of the two instruments is maintained indefinitely. To establish synchronism at the start, the two pendulums being brought to the same position, the sending-instrument being turned at hazard sends to the corresponding receiver, at each turn, a correcting current, which is printed in the shape of a dash upon the paper. This dash is brought by a slight acceleration within the sphere of the correcting current. The equilibrium is established and the system of correction maintains it.*

* The explanation given of the method by which synchronism is maintained is not sufficiently clear in the absence of diagrams io illustrate it. The system is, however, quite successful in practice.

It is thus seen that, the two instruments revolving synchronously, the two "frotteurs" describe upon their respective distributors equal and identical circles. The current passing through the wire while the frotteur passes the first quarter circle operates the first receiver and so on. Each operator has, therefore, the line at his exclusive disposal as well for reception as for transmission during the quarter turn. It is during this time that he transmits or receives his letter, one at each quarter revolution. He is "cut off" from the wire for the rest of the revolution, and cannot interfere with his neighbors. After each emission of the current, the line is put to earth by one of the sixteen divisions of the distributor, and discharged from the circuit. All the transmissions can be made at will in the same or part in one and the rest in the opposite direction.

15. The above-described instrument has been used between Paris and Lyons every day with the following results:

Maximum, per operator, 28 messages per hour.

Average, per operator, 23 messages per hour.

Maximum, per line, 110 messages per hour.

Average, per line, 92, or 600 messages in seven hours.

This is said to be double the capacity of the Hughes and four times that of the Morse instrument. Increasing the number of key-boards and receivers would, of course, increase the capacity of the apparatus in equal ratio. Like all instruments requiring synchronism, the wire must be in the best possible order to permit its use.

The cost of the apparatus is estimated at as many times that of the Morse as there are transmitters.

For this apparatus, and for his autographic instrument, M. Meyer received a Diploma of Honor (the highest prize) from the jury. It is said that the principle of the spiral used in both instruments has been before applied, but not, it is believed, to telegraphic apparatus.

A "multiple" printing-instrument has been patented in this country by Mr. Merritt Gally, whose printing-instrument was recorded in the American catalogue, but, as before stated, was not exhibited. The writer had the pleasure of making a hasty inspection of it last summer in Rochester in company with the inventor. It is bold and original in conception; the design being to allow not only terminal but also way offices to correspond with each other in the intervals, and to print the letters in Roman characters, and considerable ingenuity is displayed in its elaboration. The crudity of its construction, however, and the apparently insufficient means of procuring synchronism, render its success in its present state doubtful.

16. On an entirely different principle from that of either the "automatic" so-styled or the "multiple" apparatus are based what are called the simultaneous double-transmission systems. They do not seek to utilize the large number of pulsations, or emissions, into which a single current is capable of being broken up, but, by varying the strength of

the current, to produce different effects upon different instruments; all of which are at the same time connected to the wire.

In 1855, Dr. Stark, of Vienna, devised a method of arranging circuits with two batteries of unequal power at the transmitting end, brought into circuit by separate Morse keys; the circuit passing at the receiving end through two relay-magnets, of which the one nearest the line should have its armature adjusted with a strong spring, and the other with a weaker one.

The current of the weaker battery when launched alone upon the wire passed through the coils of the first magnet without being able to overcome the force of the spring, and affected only the second relay. The current of the stronger battery was sufficient to overcome the spring of the first relay, and caused its armature to be attracted. This armature closed the circuit of a local battery, whose current, passing through an adjustable resistance around an outer coil on the second relay in a direction opposite to that of the line-current, was just sufficient to neutralize the effect of the latter upon it. The closing of the second key would now bring into the circuit the current from the smaller battery, which, added to the current from the larger one, would overcome the opposite local current, and again work the more weakly-adjusted relay. In this manner, the current from each battery, whether put in motion at the same time as that from the other or not, would only affect its proper receiving-magnet. Similar devices were proposed about the same time by Kramer, of Berlin, and later by Schroeder.

Previous to this, and as far back as 1849, Messrs. Siemens and Halske had conceived the idea of simultaneous transmission in opposite directions upon the same wire, and had patented an arrangement in England to accomplish that purpose. Five years later, Mr. Frischen placed in the line between Göttingen and Hanover a similar apparatus. The manner of accomplishing this object being essentially the same in both instruments, the interests of Mr. Frischen and Messrs. Siemen and Halske were consolidated. The latter soon brought out another method. Still another was proposed by Dr. Ginth, of Vienna; and one year later Edlund made experiments in the same direction in Sweden, and Boesche, of Leyden, in Germany. These were followed by Bruce and Winter in England; Vates, whose instruments were used on the lines in Holland; and most recently by Stearns, of Boston, Kosmota, of Pesth, in Hungary, and Vianisi, of Florence, in Italy. All of these systems were based on a fundamental idea, although the modes of realization were different, and that idea, which is the same as that embodied in the apparatus of Stark above described, was the affecting of various receiving-apparatus by currents of different power. (An inspector of telegraphs in the Netherlands has, it is true, conceived the idea of producing effects by the transmission of frictional currents over a wire without interfering with the galvanic currents already circulating on it, but thus far the device has been without practical result.) The only instrument of this

class exhibited at Vienna was that of Kosmota, (employing a rheostat of citric acid,) of which two were in use in Hungary in 1872.

17. The most successful of these systems in its practical application is, as usual, the American; the apparatus of Mr. Stearns, of Boston, having come into very general use both in this country and in Great Britain. A description of one of the modes by which Mr. Stearns has

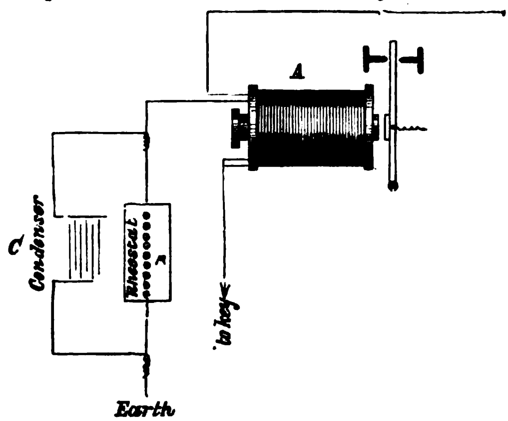


FIG. 9.—Stearn's duplex telegraph.

brought about this most desirable result is given herewith, as taken from the specifications in the Patent-Office; Fig. 9 representing the "differential" relay, which is most used in practice.

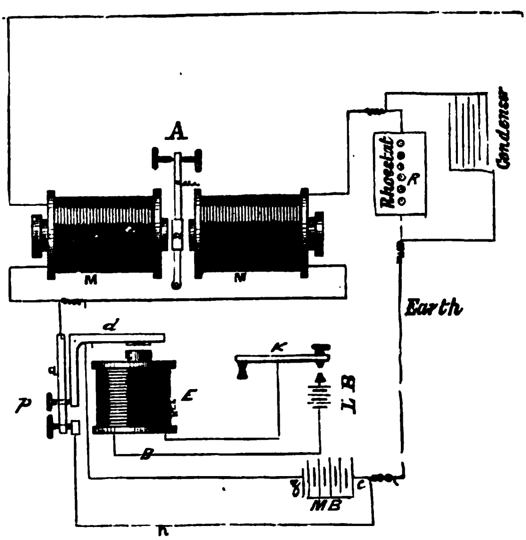


FIG. 10.—Stearn's duplex telegraph.

"Fig. 9 is a diagram showing the combination of a condenser with one form of double-transmitting apparatus, and Fig. 10 a diagram showing the combination of a condenser with another form of the same.

"As the apparatus at each terminal station is similar, the diagram represents the apparatus at one station only, A being the receiving-instrument or relay; K, the key; R, the main resistance; M B, the main battery; and C, the condenser.

"The conditions necessary for success in apparatus for the double transmission of signals are, first, having each relay at either station always in the circuit on the line; second, preventing the transmission of currents from either station from affecting the relay at that station; and, third, maintaining the resistance of the line always the same.

"These conditions are fulfilled in the apparatus represented in the diagrams in the following manner:

"In the apparatus represented in Fig. 10 of the drawing, and before referred to, the relay or receiving-instrument A consists of two electro-magnets *m m'*, opposed to each other, and having an armature common to both. When the circuit is closed, the current passes from the main battery M B to the key *d*; thence through back stop *p* to point *o*, where it divides, one portion passing through the electro-magnet *m* of the relay or receiving-instrument to the line, the other portion through the electro-magnet *m'* of the relay or receiving-instrument to a rheostat, or resistance-coil, R, having the same or nearly the same resistance as the line, and thence to the earth. The electro-magnets *m m'* being thus simultaneously excited by currents of the same strength, and being opposed, neutralize each other's effect upon the armature common to both, so that it does not move, and consequently no indication is given that a current is transmitted from the station; but when a current is transmitted from the distant station it passes through the magnet *m* only of the relay or receiving-instrument at the home station, and thence to the earth, but not through the magnet *m'* of the relay, on account of the resistance-coil between the relay and the earth, and consequently the equilibrium between the magnetic forces of the two magnets *m m'* is disturbed, and the armature is attracted by the stronger magnet.

"It is thus seen that the relay or receiving-instrument at the home station responds only to the currents transmitted from the distant station, and not the currents transmitted from the station where it is situated; and consequently the two stations are enabled to send simultaneously, the respective relays at each station, though always in the circuit, responding only to the currents from the other station.

"In operating this apparatus, it is preferred to use, instead of the ordinary finger-key, a key which is operated by an electro-magnet excited by a local battery, and controlled by an ordinary finger-key, as shown in Fig. 10, in which K is the finger-key; L B, the local battery; E, the electro-magnet; *d*, the armature-lever; *e*, a lever connected to the relay at *o*, and having two contact-screws, through which connections are made, one with the line, the other with the earth. On depressing the key K, the lever *d* is attached, and the current passes from the main battery M B through *d p e* to *o*, where it divides, one portion pass-

ing through *m* to line, the other through *m′* and R to earth. When the key K is opened, the lever *d* is released, and the line connected to earth through back-contact and wire *n*.

"It is obviously a matter of great importance that the resistance presented by the apparatus at one station to the current from the opposite or remote station should always be perfectly uniform, irrespective of the position of the circuit-breaker. To effect this, it is necessary that the resistance between the lever *a* and the earth by way of *e p* should be equal to that by way of *b d* M B. A small resistance, which is made equal to the internal resistance of the battery M B, is therefore interposed between the anvil *p* and the earth, as represented in the patents referred to.

"It is a well-known phenomenon in the operation of the electric telegraph that a submarine subterranean, or long land-line wire, when well insulated, acquires, when connected with a battery, what is known as the "static charge," and that when the wire is disconnected with the battery and put to earth, the discharge of this accumulated electricity gives rise to a return current in an opposite direction to the current from the battery. This current is found upon the lines referred to a serious obstacle to the successful operation of a double-transmitting apparatus; for when the battery at the sending station is disconnected and the line put to earth, the relay or other receiving-instrument at that station, which, as has been before explained, should be perfectly quiet, is affected by the return current, which passes through the opposing magnets or coils of the relay, and disturbs the balance of the magnetic forces, therefore producing a momentary attraction of the armature, and a consequent confusion of the signals. To obviate this difficulty, there is combined with the branch or compensating circuit passing through one of the coils, or one of the magnets of the relay or other receiving-instrument to the resistance, and thence to the earth, a condenser of any of the well-known forms in use, which receives a static charge at the same time as the line, when the latter is connected to the battery, and when the line is disconnected sends a return current, which neutralizes the effect of that coming from the line, and thus prevents the relay from being affected. The condenser is shown at C, as in Fig. 9 and Fig. 10. It may be made of alternate strips or plates of tin-foil and some insulating material."

The main portion of Mr. Stearns' device is the application of the condenser, which, it will be remarked, is substantially different from that used to avoid the return current in the automatic system, and which it was claimed was used by Dr. Werner Siemens for a similar purpose upon the Red Sea cable.

Its use upon short lines is, moreover, unnecessary. In interesting reviews of this subject by Dr. Edward Zetzche, eminent German authority, and Mr. Louis Schwendlar, superintendent of Indian telegraphs, (*Journal télégraphique*, 1874 and 1875,) reasons are assigned

for the neglect of the duplex or simultaneous telegraph which was manifested until the energy of Mr. Stearns brought it to the front. Among these are complexity of character as compared with the ordinary Morse, the bad construction of telegraph-lines which formerly prevailed, and which rendered its use more difficult than at present; and the fact that until recently the wires have not been crowded with messages, except in case of interruption by bad weather, or, if so, that surplus has generally accumulated at one end of a circuit, and not at both. The position of Mr. Stearns as president of a telegraph company, it is suggested, enabled him to bring it into successful operation much sooner than he could have done in another capacity; and as a strong illustration of the difficulties which attend inventors, the fact is to be mentioned that for some years after the instrument had been working satisfactorily upon his lines, the idea of its utility or even practicability was derided in the official reports of the company, which has since purchased the patent, and values it, as stated by its officers, at a million of dollars.

Be this as it may, Mr. Stearns is entitled to great credit for the general introduction of his system. In common with all duplex telegraphs, it has the disadvantage of requiring a close adjustment of resistances and of electro-motor forces, of being deranged in its working, and rendered practically useless during electrical disturbances upon the wires, and also of not permitting the receiving operator to "break," or interrupt, the sender, in case he does not understand a signal. This can, however, be done by the sender at the same station, and the only serious embarrassment would occur in the continuous transmission of messages requiring to be repeated, or those, such as international messages in Europe, to which the acknowledging signal "O K," or its European equivalent, is required to be given. Notwithstanding these objections, the use of the duplex is undoubtedly destined to be greatly extended.

18. In Sabine, "Electric Telegraph," from which the account before given of Dr. Stark's arrangement for double transmission in the same direction is taken, it is stated that it had been combined with double transmission in opposite directions, so as to permit of four messages being sent simultaneously on one wire. Dr. Zetzche also states that Kramer, of Berlin, made experiments with a view to combining the two systems.

The most successful invention in this direction is that of Mr. T. A. Edison, of Newark, N. J., to whom telegraphy is indebted for many novel and valuable ideas, especially in connection with the automatic system. A description of this apparatus, now in operation on the lines of the Western Union Company, is given herewith.

The "electro-motorgraph" of Mr. Edison, Figs. 11 and 12, was exhibited before the Society of Telegraph Engineers, and before the Royal Society, where it attracted great attention.

The inventor states that he has a machine in operation in his labora-

tory, upon the principle shown in Fig. 11, with which he has succeeded in repeating automatic signals from one circuit into another, at the rate of one thousand two hundred words per minute, an average of six thousand letters, or twenty-four thousand waves per minute, compelling the lever A to move backward and forward from the point on the left to the point D on the right four hundred times per second.

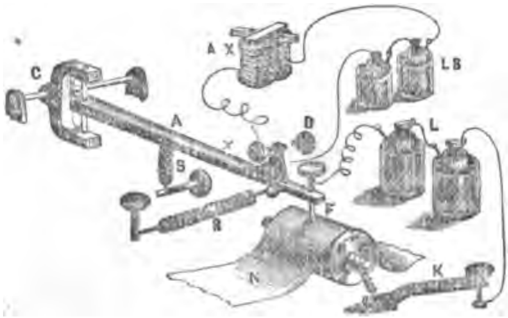


FIG. 11.—Electro-motorgraph.

In Fig. 11, A is a lever pivoted upon a universal joint, C, and is provided at its extreme end with a screw, F, tipped with platina, resting upon a strip of moistened paper, which is carried forward (in the direction shown by the arrow) by the drum G. This drum, G, is continuously rotated by a clock-work, (not shown.)

The spring S is used for the purpose of creating a pressure of the point F on the moistened paper. The spring R is to draw the lever to the left and against the point X.

L is a main battery, K a key.

The zinc pole of the battery is connected to the point F, while the carbon pole is connected to the metallic drum G, through the key K. When K is closed, the chemicals with which the paper is saturated are decomposed by the passage of the current through the paper, and the lever rests against the point X, closing the local circuit containing the sounder A X, and local battery L B, (this may be a main circuit with a chemical recording-instrument at other end.) If the key K is opened the normal friction of the platina point F upon the paper is so great that the spring R is insufficient to keep it against the point X, and it is carried forward by the rotation of the drum to the point D, where it remains until the key K is again closed; then the friction by the passage of the current is reduced to mere nothing, and the spring R easily pulls it against X, where it remains as long as the current is allowed to pass. As will be seen from this brief description, the lever is moved backward and forward by a difference in frictions brought about by the decomposition of the chemicals on the passage of the current. Mr. Edison uses a solution of chloride of sodium and pyrogallic acid.

Why the paper becomes extremely "slippery" on the passage of the current he is unable to state. With the instrument he now has he can

work it as a relay and receive from Washington with only two cells of the main battery. It is extremely delicate.

Unlike a magnet, no secondary currents are set up, upon opening and closing, to delay the movements of the lever, as with an electro-magnet; neither has it cores like a magnet to consume more time, in charging and discharging, but moves with a maximum effect instantly.

The plan shown in Fig. 12 is what the inventor calls a *polarized motorgraph.*

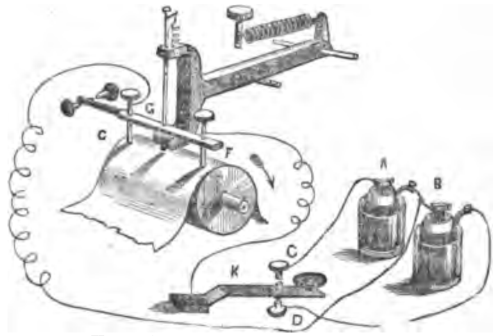


FIG. 12.—Polarized motorgraph.

The key K alternately connects the batteries A and B to the lever of the motorgraph, one sending a positive current, the other a negative current. The current say from the battery A, passes to the point X, thence through the paper to the point G, up through G back to the other end of the battery A. Thus hydrogen is generated on the point F, which becomes slippery, while oxygen is generated on the point G, which retains its normal friction, hence the point G is carried to the right by the rotation of the drum. If the direction of the current be reversed by putting on the battery B, hydrogen is generated on the point G, which becomes slippery, and oxygen on F, which retains its normal friction, and the lever is thrown to the left.

The diagram is arranged merely to illustrate the principle of the invention.

In his practice, Mr. Edison uses a single battery and reversing-key.

19. The *Illimit-Apparat* of Mr. Bauer, of Vienna, shown in the pavilion of the ministry of commerce, is not yet successfully completed, and is too complicated for description.

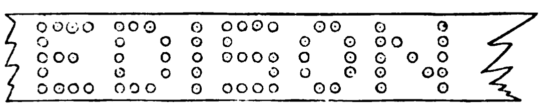
20. There was little progress exhibited in printing-instruments. Messrs. Dujardin and D'Arlincourt appeared with new printers, each with two type-wheels, and Messrs. Schaeffer and Bauer with a bourse or stock reporter, one for two and the other for three wires, not superior if equal to the type in use in America. Siemens's dial-printer of latest form, patented in 1872, has only one row of letters placed on button-keys, serving as well for transmitting as receiving signals, and the crank used in his old form is done away with. Each key remains depressed until the next is touched. An arrangement is also provided

for suppressing one of the induction-currents in order to give a special signal on an alarm at an intermediate station. The automatic type-printer of Bonelli has been described in the Paris reports.

In August, Dr. Werner Siemens brought from Berlin the latest form of rapid printer with automatic transmission. The transmitter and receiver are placed close together. The type-wheel is controlled by two escapements, one of which is put in motion by brief currents in one direction, and advances the type-wheel four letters at once, while the other only moves it the space of one letter, so that eight currents at most (the average being three or four) suffice to print any one of the thirty-one signs used, the wheel returning after each impression to its point of rest, while the wheel of the Hughes instrument must make an average of from seventeen to eighteen steps to reach a letter.

An improvement in type-printing telegraphs is said to have been made by Mr. Phelps, the originator of the excellent combination system which bears his name, and is in use on several of the more important circuits in this country. By punching paper at distances corresponding to those of the letters designed to be printed, an automatic transmitter is produced, giving the same results as the present arrangement of keys on his key-board. By simplifying the motors, and doing away with much of the machinery now used in his compressed-air-power instrument, it is said that consecutive letters can be printed at a single revolution of the cylinder. This instrument, however, has not yet been put into operation.

Another automatic-printing method is that proposed by Mr. Edison as an improvement upon the present automatic Morse writing-system. The letters to be transmitted are punched in the paper-strip in Roman capitals thus—



instead of in a dot-dash code, and by the use of several wires are recorded at the other end on the chemically-prepared paper.

Neither the Bain, Bakewell, Caselli, nor the Le Noir apparatus was on exhibition; in their places, however, were found the Meyer and the D'Arlincourt, both in the French department.

While in Paris, the writer was told that M. Le Noir was perfecting some important modifications in his instrument; but, owing to his absence from the city, it was impossible to inspect it.

21. The Meyer apparatus, which, since 1868, has been employed on French lines formerly served by the Caselli, is described as follows:

The sending-cylinder A (Fig. 13) is insulated, and upon it is wound the message written with an insulating ink upon a sheet of metallic paper. An endless screw, H, is moved by clock-work, and carries a car, I, armed with a brush of metallic wires, D, and a metal point, C. The

brush and point are insulated from each other, and rub constantly against the surface of the paper.

For each turn of the cylinder A, the car moves forward one thread of the screw, or a distance of $\frac{1}{4}$ millimeter, so that each point of the surface of the cylinder is brought successively in contact with the point C. This point is connected permanently with the ground.

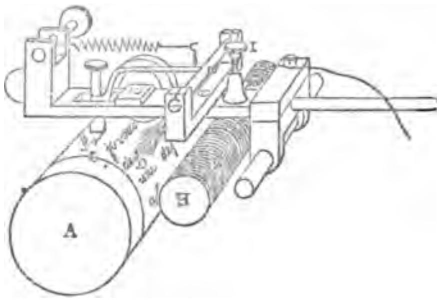


FIG. 13.—Meyer's apparatus.

At the transmitting station, the positive pole of the battery is connected constantly on the one hand with the brush D, and on the other with the line-wire. The battery is therefore continually in action, but the distribution of its current depends upon the position of the stylus C. When the latter touches the metallic surface of the paper, the circuit is closed by the way of the brush D, the paper, the stylus, and the ground. Almost the entire current passess into this short circuit, and the line receives only a small portion, which may be left altogether out of account. When, on the contrary, the stylus C touches a part of the insulating ink, the short circuit is broken, and the battery-current passes entirely over the line.

The receiving cylinder B, Fig. 14, carries a spiral thread like that described in the multiple transmitter of Meyer, except that it extends entirely around the cylinder. This thread rubs continually against an ink-roller. The paper is unrolled by clock-work, and brought up to the spiral by the action of an electro-magnet, exactly as in the multiple system. The apparatus for synchronism is also similar to that before described.

If the circuit is closed and the paper is brought in contact with the spiral during a whole turn of the latter, a straight line is drawn across it; at the commencement of another turn a new line is begun, and so on. It will thus be seen that whenever the transmitting-stylus touches the ink, permitting a current to pass over the line, the paper receives an impression corresponding to the length of the emission. The writing on the metallic paper is thus reproduced at the receiving-end.

The electro-magnets used are of the polarized pattern before described, the one employed to lift the paper-frame being worked by a local current. Mr. Meyer claims to have recorded with them signals at the rate of 20,000 to 30,000 a minute. In the tests of his apparatus, which we witnessed, the paper, which is about 3 by 4 inches, occupied some four minutes in passing under the stylus. The lines drawn by the stylus are one-eightieth of an inch apart, and if the transmitting-paper were to be covered with dots placed at that interval apart, the surface would hold 76,800, each of which would give a separate emission and record, making an average of nearly 19,000 per minute. With a view of testing the

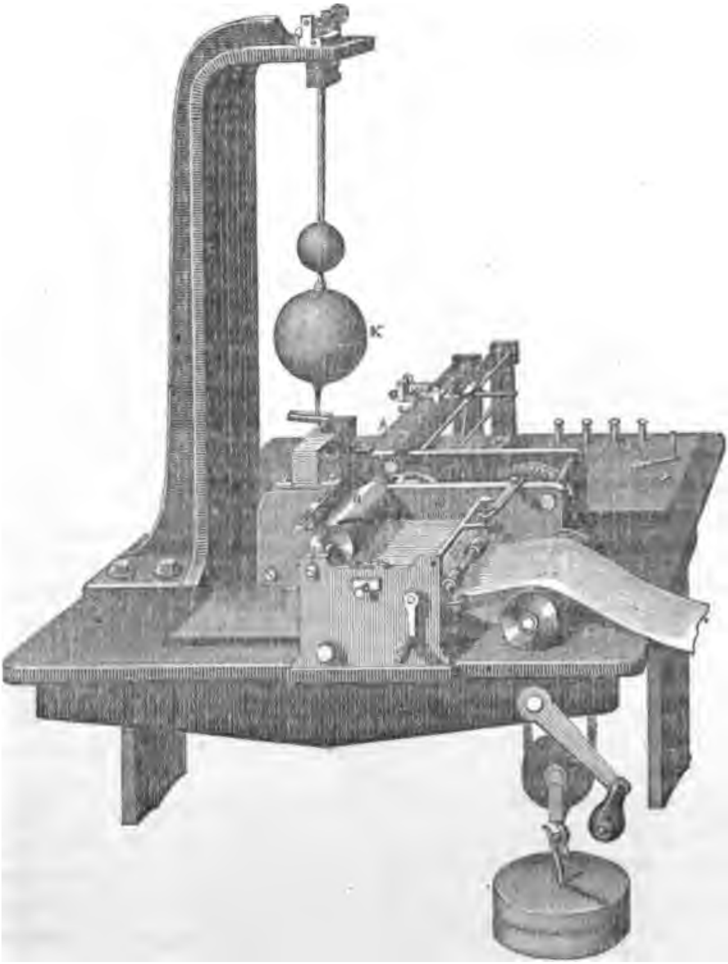


Fig. 14.—Meyer's apparatus.

accuracy of the copying, the writer asked a member of the Japanese commission to write a message in his own language, and on passing it through the instrument it was found to be transcribed with almost absolute correctness. We then wrote a letter in stenographic characters, only a portion of which when copied was legible. The defects were apparently traceable, however, to the quality of the ink and of the paper. With ordinary writing, there seemed to be no difficulty; and, as the only ink-writing *fac-simile* telegraph, the invention of M. Meyer is worthy of the honors which it shared with the multiple.

22. M. D'Arlincourt's apparatus is a chemical copying-telegraph. Owing to the lack of prepared paper, it was only in operation a short time during M. D'Arlincourt's stay at Vienna; hence it was impossible to inspect it as fully as was desired. The transmitting and receiving apparatus consists of a cylinder similar to that used by Meyer for sending, with a stylus moving over its surface in the same manner. The cylinder is connected permanently to the ground, and when used for transmitting is covered with the metallic sheet on which the message has been written; the metallic surface and the cylinder being connected electrically while the stylus is attached to the battery and the line-wire at the receiving-end, the circuit is made through the stylus and the paper to the receiving-cylinder. Mechanical synchronism is attained by the use of a *circular diapason*. In addition to this, an arrangement is made whereby the transmitter, revolving a trifle more slowly than the receiver, is arrested at each revolution and released by the action of a current sent from the battery of the receiving-station, which is brought into circuit at each turn of the receiving-cylinder. This arrangement M. D'Arlincourt considers the cardinal point of his invention. To describe the mechanism of the apparatus would require too much space, but from the foregoing its general operation will be easily understood. The specimens of writing produced by this instrument compare most favorably with those of the Meyer, Lenoir, or Caselli systems.

For the work of releasing the transmitting-apparatus, M. D'Arlincourt avails himself of a relay of his own invention, which involves a most ingenious principle, and which, together with his *fac-simile* and printing telegraphs, gained him the Diploma of Honor. Its design and effect are, briefly, to get rid of the effect of the "residuary" magnetism remaining in the cores of an electro magnet (and thus of the necessity of adjustment) by forcing it to act in a contrary direction to the original attraction, and of itself to repel the armature. The following is an extract from M. D'Arlincourt's description of his relay, (*Annales de l'école normale supérieure*, second series, vol. II:)

"Fig. 15 represents an ordinary electro-magnet of soft iron. By the passage of the current the iron cores become magnetic, the south pole being at A and the north pole at B. The greatest attractive force of the magnet is near its free extremities. It decreases as the base E is approached, near which it is very feeble. Each of the coils C D, dur-

ing the passage of the current, itself represents a magnet whose poles, or *maxima* of magnetic force, are situated at its extremities, as shown by the small letters *a b*. Near the base E, between two enlargements of the soft-iron cores, is placed the south pole *a* of a polarized armature, *(palette,)* P, which oscillates between the points of two adjustable screws, V V′. When the current passes, the south pole of this armature is acted upon by two sets of forces.

"1st. The enlargement of the branch B acts as a north pole, and attracts the armature; that of the branch A as a south pole, and repels it. The combined action of this first set of forces tends, therefore, to direct the armature toward the point of V′. It must be remembered that this all takes place in the vicinity of E, or the neutral line, where the concurrent magnetic action of the two branches of the electro-magnet is very slight.

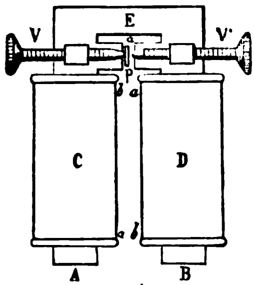


FIG. 15.—D'Arlincourt's relay.

"2d. The extremity *a* of the coil D is a south pole, and repels the armature; at the same time the extremity *b* of the coil C, which is a north pole, attracts it. The total action ot this second set of forces tends, therefore, to throw the armature over to V.

"Of these two opposing combinations of forces the latter is evidently the stronger, and the armature is attracted to V, where it remains during the passage of current.

"At the instant the circuit is broken, the magnetic action of the two coils ceases. This, however, is not the case with that of the soft-iron cores, whose magnetism remains and is even heightened by the extra current following the breaking of the circuit. Subject only to the action of the cores, the armature is, as above shown, thrown over to the point of V′, where it remains as long as the circuit is open.

"By turning the screw V′ so as to permit the armature P to come very near the enlargement of the core A, as in Fig. 16, the magnetism of the south pole of the armature may be made to overcome the similar magnetism in the enlargement of the core and change its polarity. The armature would then rest upon V, and the passage of the current, as before, would only confine it in its position. But upon the breaking of the circuit, the magnetic force of the extra current in C *being added to that of the direct current*, so influences the enlargement of the core as to make its polarity of the same name with that of the armature sufficiently strong to repel the latter, which flies over to V′.

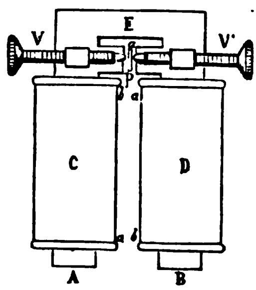


FIG. 16.—D'Arlincourt's relay.

" While the armature executes this movement, however, intensity of

the residuary magnetism of the cores is considerably reduced, and that of A becomes so feeble as again to permit the armature to be attracted toward it by the overpowering influence exerted upon it at that short distance by the pole *a* of the armature.

"The relay may thus be adjusted so that the armature will remain immovable during the passage of the current, and on its cessation will fly over to V′ and immediately return."

This form is singularly but expressively called by M. D'Arlincourt a relay *à coup de fouet*, and is used in an ingenious manner, in combination with the other form, in an open-circuit repeater, which has worked for more than a year in Paris on the line from London to Marseilles, with very satisfactory results, as attested by M. Bréguet. The function of the relay *à coup de fouet* is the discharge of the secondary current from the line.

The form most approved by M. D'Arlincourt for the construction of his relay is one in which the armature P, instead of being a magnetized piece of steel, liable in the course of time to lose its polarity, is made of soft iron and hinged permanently to the south pole of a fixed horseshoe magnet, and is constantly fed, so to speak, by the latter.

The use of this relay, it is said, has entirely done away with the difficulties of transmission in several of the channel and North Sea cables, and the rapidity of its action is such that with it he has worked his *facsimile* telegraph to a distance of from nine hundred to twelve hundred kilometers, (five hundred and thirty-two to seven hundred and ten miles.)

23. AUXILIARY APPARATUS.—A number of commutators, lightning-arresters, rheostats, &c., were shown in various departments, none of which deserve extended mention. Among the testing-instruments were the Wheatstone bridge and Seimens universal galvanometers; also, a new mirror-galvanometer of Siemens and Halske, in which the needle is of a new form, and does not oscillate about its point of rest after having been affected by the current. The French administration exhibited the system of underground pneumatic tubes in use in Paris for transmitting messages between the central and branch offices. Similar tubes are also in use in London. In the French system an ingenious contrivance is used for localizing faults, such as the stoppage of one of the cylindrical message-boxes. A pistol is fired at the mouth of the tube and the waves of sound recorded, and by this means the position of the object is accurately determined. This is the invention of M. Bontemps, an inspector, to whom we were indebted for courtesies while in Paris.

There was also quite a large display of electrical instruments used in meteorology, in medicine, and other departments of science, including a chronoscope invented by a Japanese. An electric clock, sent over by Messrs. Autenreith & Himmer, of New York, was set up in the American department, but, owing to some defect in or some injury to its mechanical construction, it would not keep time, and was therefore unable to compete with the fine exhibits of Hipp, of Neufchatel, and others.

24. HISTORICAL COLLECTION OF THE GERMAN GOVERNMENT.—Not the least interesting gallery in the Exhibition building was that which contained the historical collections of the German telegraphic and postal administrations; and had the former been aided, as was suggested by Dr. Siemens, by the telegraphic authorities of other countries, in making the exhibit an international one, no one portion of the Exhibition could have been made more valuable and instructive. A full account of the telegraphic collection was published by Dr. Ed. Zetzsche, in the *Ausstellung -blatte* of the Vienna Neue Freie Presse, and from it is extracted the following:

"In the attempts made, as is well known, commencing in 1753, to apply static electricity to telegraphy, Germany participated in 1794, in the person of Reusser and of Bockmann. The first proposed to arrange letters in squares which should be made visible by a spark from a Leyden jar; the second, to represent letters and numbers by a series of sparks conveniently arranged. Neither of these systems is represented at the Exhibition. Like others, they were unsuccessful. The only system for the application of frictional electricity which presented any chance of successful working is that of Sir Francis Ronald, who died this year, (1873,) and whose apparatus, invented in 1816, may be considered as the first 'dial' instrument.

"It was Samuel Thomas Sommering, born at Thorn in 1755, but resident at Munich from 1805, as a member of the academy of that city, who first, in the month of July, 1809, applied to telegraphy galvanic or *contact* electricity, which had been known since the end of the eighteenth century. His apparatus, the oldest of those exhibited, rested on the idea of evolving signals from the chemical effect of the current, *i. e.*, the decomposition of water by galvanic electricity, which had been first observed by Carlisle in 1800.

"Sommering took 27 wires of brass, which he insulated first with a covering of gum lac and afterward with silk thread, and united them in a thread-covered cable of 1,000 feet in length. He then covered this cable with heated gum lac or with a ribbon plunged in a solution of the same substance. He united these wires, which represented the 25 letters of the alphabet, the period, and the signal for repetition, at one of their extremities with 27 strips of gold placed upon cork at the bottom of a glass trough filled with water, whose interior dimensions were 170 millimeters in length by 25 in width and 65 in height. The other ends of the wires were attached by 27 pins to a small board. The galvanic pile was composed of 15 Brabant crowns and 15 plates of zinc, separated by round pieces of felt moistened with a saturated solution of common salt; to its poles were attached plugs of different forms which could be placed in the holes of the pins or bolts above mentioned.

"When, therefore, the plugs were placed simultaneously in the holes of two of the bolts, they were connected to two of the gold strips, and at one the current produced hydrogen and at the other oxygen. In this

manner Sommering transmitted at first two letters at once, one by the production of hydrogen and the other by that of oxygen. Later he used only one letter at a time, the one indicated by the release of the hydrogen.

"The apparatus exhibited at Vienna, which belongs to the family of Sommering, is provided with a lever alarm, invented in 1811. Sommering had already, in 1809, attempted to cover his cable with a solution of caoutchouc, in order to use it under water.

"It would undoubtedly have been possible to communicate with this apparatus. The dangers of explosive gas would have been avoided, and the number of wires, as proposed by Schweigger, been considerably reduced. However, the telegraph of Sommering received no more practical application than that proposed by Prof. John Redman Coxe, of Philadelphia, in 1810, to utilize for telegraphic purposes the decomposing action of the current upon different salts. But before the need of a telegraph was seriously felt, other and better processes were discovered.

"Even after Professor Oersted, of Copenhagen, had observed the deviation of a magnetic needle under the influence of the current, neither the proposition of Ampère, at Paris, in 1820, (of employing 30 needles and 60 wires,) nor that of Fichner, at Leipsic, in 1829, (24 needles and 48 wires,) gave any impulse to telegraphy. Only in 1832 did the Russian councilor of state, Baron Schilling de Kannstadt, of German origin, who had seen the telegraph of Sommering, with whom he was intimately associated, and had made it known in Russia, invent a new instrument with but five wires, which number he subsequently reduced to one. A design only of this telegraph was shown at Vienna, the original being preserved by the Académie of Sciences in St. Petersburg. In it the movements of the needle were rendered more perceptible by means of little disks of paper attached to a silk thread which held the needle in suspension. This telegraph, it is true, was not put in application on a large scale, for Schilling died in 1837. But in 1835 he had brought out his apparatus at Bonn and at Frankfort-on-the-Main, where it was seen, among other persons, by Professor Muncke, who probably constructed a similar one and carried it with him to Heidelberg. There also, in 1836, Schilling met Cook, and persuaded him to devote himself altogether to telegraphy.

"The first telegraph upon a large scale was constructed in 1833, at Göttingen, by Profs. Charles Frederic Gauss and William Weber, on a line of 3,000 feet in length. It remained in use until 1838. The line itself, which passed over a tower of the town, was destroyed by lightning in the summer of 1844. This telegraph, now the property of the laboratory of physics at Göttingen, was exhibited, not in its first form for the use of galvanic electricity, but in that given it in 1835 to be actuated by induction currents. The needle of the receiver is an enormous magnetized bar of 1.21 meters in length, 75 millimeters wide, and

15 millimeters thick. The multiplying-coil surrounding it is in its turn inclosed in a 'moderating' coil consisting of a few turns of large copper wire. The needle in its oscillations carries with it a small mirror, which is observed by the aid of a glass. The transmitting-apparatus has an induction-coil which is placed upon a large magnetized bar, and can be moved above the bar by one or the other of two levers. The piece joining these two levers turns upon a horizontal axis and constitutes a commutator, which emits the current in the multiplier-cylinder first in one direction and then in another, and thus moves the suspended needle to the right or left. The transmission of the twenty letters and nine figures required at the most the use of four currents.

"Gauss induced Prof. Charles Auguste Steinheil, of Munich, to interest himself in telegraphy. While De Jacquin and A. von Ettingshausen established in 1836 a telegraphic line, partly over and partly under ground, across certain streets in Vienna, Steinheil constructed a line about four miles in length, with two wires, between Munich and the observatory of Bogenhausen, and in July 1837 transmitted signals with his apparatus, which is exhibited at Vienna, and which may be called a 'needle' transformed into a 'writing' telegraph. This instrument, invented in 1836, has for transmitter a magnetic inductor turning around a vertical axis with a mercury commutator. The receiver consists of two small steel magnets, each movable upon a vertical support placed within a multiplier-coil traversed by an induction-current. These two magnets are provided at one of their extremities with a little ink-receptacle and at the other with a small brass hammer. By means of a regulating-magnet placed in front, they are so arranged that a current passing in one or the other direction puts in motion the first or the second of these magnets and establishes in either case a contact between the ink-holder and a band of paper which passes or strikes with the hammer-end against one or the other of two bells placed at convenient distances and giving forth different musical tones. The alphabet of Steinheil, formed only of *dots* arranged in two different lines, presents the great advantage of being produced by currents of equal duration though of opposite directions. It is to be remembered that Steinheil had in 1838 discovered the possibility of using the earth instead of a second wire for the return of the current.

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"The oldest dial-instrument exhibited in the historical section was constructed in 1845 by Leonhard, in Berlin. In the receiver the current acts directly upon a needle, which turns gradually a ratchet-wheel fixed to its axis by means of an escapement, while in the transmitting-apparatus the circuit is broken and closed by means of wheels.

"The next oldest instrument of the dial-system is that of Siemens, which was patented in Prussia in 1846 and exhibited at Paris in 1850. This telegraph, constructed upon a new principle, operates (as does the alarm joined to it) by automatic interruptions of the current. This is also the oldest printing-telegraph exhibited. It is furnished with an

arrangement for making a dry impression of the desired letter by means of copying-paper upon a moving paper band. This instrument is further remarkable in that the local current, transmitted through a special printing-magnet, interrupts itself as soon as it has accomplished its work, by reversing a lever, and that the type-wheel, the letters of which are fixed, not directly upon the circumference of the wheel but upon springs arranged in the form of *radii*, commences a new turn. While the wheel is turning, the local current, it is true, passes over the printing-magnet, but it is at the same time, with the line-current, interrupted and re-established so rapidly that the magnet cannot attract its heavy armature. If by pressing upon a key of the transmitting-apparatus when the pointer reaches a certain letter a longer current is transmitted, the receiving type-wheel is stopped upon the corresponding letter, and the local circuit is then closed for a longer time, the little printing-hammer lifts, in striking it, the depressed type and forces it against the band of paper, which itself presses against the printing-cylinder above the type. The local circuit is immediately broken and a spring draws the hammer back to its point of repose, while the line-current which follows replaces the interrupting-lever of the local current in the position where it closes this circuit. We mention the fact that it was to this apparatus that 'translation' was first applied.

"The historical collection contains still another dial-telegraph, that invented by Dr. Kramer, of Nordhausen, in 1849. This instrument, it is true, works also by means of automatic interruptions of the current, but the pointer-needle is put in motion by a series of clock-work moved by a weight. Unfortunately, the pendulum which serves as relay to this apparatus was not exhibited, nor were the dial-instruments of Fardely and Drescher. On the other hand, there was a dial and induction telegraph of Stöhrer, constructed in the workshops of the Bavarian telegraphic administration. Emile Stöhrer, of Leipsic, was the first who, in 1847, leaving the system of Wheatstone, applied the contrary currents produced by an inductor upon a polarized armature by means of magnetic induction. This armature communicated its oscillations immediately to an escapement, which transmitted them to a toothed wheel fixed upon the axis of the dial. Stöhrer made his inductor turn by means of a weight. Siemens subsequently invented one with the core in the shape of an H which he attached in 1857, by means of a double wheel, to a crank turned by hand above the lettered dial of the transmitting-apparatus, which permitted him to send over the line an extremely rapid series of currents. This cylindrical inductor, invented in 1850, rendered possible the accumulation of the induction-force of a greater number of magnets in the same coil. On account of its small inertia and resistance, it could be inserted directly in the circuit.

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"The Siemens automatic dial-printer, above described, was not the first of its kind, one having been previously constructed by the American

Vail, in 1837. Afterward came that of Wheatstone, in 1841, and in Germany also, upon the Tounus Railway, there had been introduced the dial-apparatus of Fardely, transformed into a printing-telegraph.

"No other printing-telegraphs have been invented in Germany;* but the historical collection contained printing-instruments of the Hughes pattern constructed in Germany and provided with 'repeaters,' working in part upon the system of Maron, with two Siemens polarized relays, and derived currents, and in part by means of the automatic commutator devised by Mr. Gustave Jaite, of Berlin.

* * * * * * *

"The oldest writing-apparatus or register in the historical collection is the embossing-instrument of Siemens. It dates from 1849, *i. e.*, from the time of the importation of the Morse telegraph into Germany. The electro-magnet of this apparatus is in a vertical position, and its armature is a cylinder cleft longitudinally on its upper part, while the lever is furnished, as in the relays of later-devised registers, with a lower arm, to which is attached the adjusting-spring.

"The next in order is the register constructed in 1853 by Siemens, and used on the Russian lines built by Siemens & Halske. This apparatus was intended for rapid writing, to secure which the core of the electro-magnet to which was attached the writing-lever was furnished with a bent attachment which in its vertical oscillations brought the two cores of the magnet nearer together, in order to obtain by the simultaneous effect of the two cores a more rapid action than that of an ordinary electro-magnet. This same arrangement is found in the magnet of the writing-instrument, with interrupting adjusting-spring, proposed by C. Frischen, in 1856, for repeating upon circuits worked with constant currents, which was also seen at the Exhibition. In the embossing-apparatus of Lewert, of Berlin, the barrel may be detached, and the movements are placed in a box, at the side of which passes the paper strip. Two of Siemens's ink-writing instruments, of 1865 and 1868, are in the Exhibition.

"There is a greater variety in the ink-writing registers. The first of these was made by Thomas John, at Prague, in 1854, the original being exhibited. The ink-wheel rubbing against an inked roller, is supported above the band of paper by a lever attached to and following the movements of the armature. The wheel is turned by a thread uniting it to the upper cylinder, which draws the paper band.

"Siemens's polarized ink-writers, constructed by him in 1857 for the Red Sea cable, and used in connection with reversed currents on the Malta cable in 1858, were also shown. On this latter cable magneto-electric induction-currents were used, and for the first time with translation. In 1859, at Aden, Siemens first used a Leyden jar as a condenser for the discharge of cables. The ink-writing apparatus of Miller, of Cologne, and Siemens's polarized instrument of 1868 were also in the historical section.

* See printing-telegraphs, *ante.*

"Also the apparatus of Stöhrer, with polarized magnets and double pen for a two-line or Steinheil alphabet, put in use in Saxony, Bavaria, in 1849 and 1858, was exhibited both by North Germany and Bavaria. These double-pen instruments (of which one for embossing, dating from 1850, with the oldest form of polarized magnet, *i. e.*, with cores not fixedly magnetic, but polarized by induction from a local electro-magnet, is also shown by Siemens) were soon superseded by the Morse single lever."

Although relays were employed in 1837 by Cooke and Wheatstone for the alarm of a needle-instrument, the oldest form in the historical section dates from 1849. It has a straight lever, while that used in Hanover in 1850 has its lever bent. Further on is a Siemens box-relay of G. Werniske, (1851,) the relay with oscillating magnets, invented by Siemens in 1853, and first used on the Russian lines with similarly-arranged register for rapid writing; also a large number of polarized relays of all kinds. Next are the relays of Nottebohm and Borggreve, both of 1857, with horizontal magnets; a relay of 1868, in which the core of the magnet can be displaced, according to the strength of the current; and, lastly, the polarized relay of Siemens, furnished with two steel magnets, two electro-magnets with sheet-iron cores, and two levers for repeating on lines worked with reverse currents. (Indo-European line, 1869.)

In transmitting-apparatus there are many patterns of Morse keys, also the three-keyed punchers for automatic transmission, and other instruments, wherein the punching and transmitting parts are closely connected, (as in the latest Hefner-Alteneck instrument, shown by Siemens.) Siemens's type setting and distributing apparatus for automatic sending are unfortunately not shown, although his apparatus patented in 1862 is found in the historical gallery.

Aside from the "repeaters" of Frischen for constant currents and of Siemens for reversed currents, the historical collection contained only a few recent inventions, notably that for the Jaite telegraph. Repeaters are, indeed, but little used in Germany or in countries for which Germany manufactures telegraphic instruments. Although the first Morse patent contained the principle of the relay or repeater for sending currents in one direction, it is claimed that the first automatic repeater was imagined in 1844 by Fardely, for his printing-instrument, and the idea perfected by Siemens in 1847, in his dial-instrument.

In the way of apparatus for double or simultaneous transmission the historical collection contained only the Freschen and Siemens differential relay, patented in Prussia in 1854, and that of Borggreve, of 1862. The absence of the numerous contrivances devised in Germany for this purpose is much to be regretted.

In the way of galvanoscopes the Exposition contained only the most recent patterns in use since 1869 and 1871, (constructed partly after the system of Varley and the hair-needle of Siemens of 1869.)

The series of alarms was complete, comprising those of Lömnering

and Schilling, the intermediate alarms of Siemens and Kramer, the station-alarm of Borggreve, and the door-contact alarm of Siemens of 1847.

A large number of lightning-arresters were also shown. The oldest (that used by Steinheil in 1846 being wanting) was the Siemens pattern of 1848, with three plates, of which the middle one was connected to ground. Then come four others of Siemens: the iron-wire coil, the iron wire and plate, the point and plate, and the point and ball-arrester. Then his vacuum-discharger of 1852 and the plate systems of Nottebohm (1857) and of Elsasser, (1866 and 1869.) All of these are for the instrument-table, but among the Bavarian patterns is one to be placed on the lines, composed of two metal cylinders, one inclosed in the other, whose lower ends being closed are separated by a piece of wood boiled in oil.

In commutators the old clamp-patterns are missing. Beside two crank-commutators in use since 1854, were three button or peg commutators and a permutator of Nottebohm, as used until 1857, as well as a series of crank and button commutators of Borggreve, and others still in use, among them that of Elsasser (1866) for testing the lines.

Of rheostats or resistances there were, aside from those of the peg-pattern, with resistances from 1 to 10,000 mercury units, a rheostat with resistances graduated by miles of line in the form of a box and with a steel crank, (Siemens, 1854,) for the use of apparatus for simultaneous transmission, a rheostat with cranks containing resistances from one to fifty miles of iron wire of $2\frac{1}{10}$ lines in diameter and the powdered graphite resistances used since 1865 at way-stations for regulating line-resistances. These are composed of graphite compressed in glass tubes, and give a resistance of from 500 to 2,500 Siemens units.

In electrical generators the historical section contained only the copper and zinc battery of Siemens (1849) and the inductors of Gauss, Steinheil, and Stöhrer, and that of Siemens for alarms and for exploding mines, together with two electro-electric inductors of the latter, one of which produces currents with a few elements of the second, which are changed to similar currents and made to transmit Morse signals over long lines, while the other gives Morse signals by means of reversed currents and polarized relays.

Along the walls of the court in front of the gallery or annex were planted a number of wooden and iron poles, which showed the different modes of construction in use since 1851 for aerial lines. The posts were sometimes single and sometimes composed of double supports, and carried, on brackets and in divers ways, single or double porcelain insulators of the bell-pattern, or cast-iron insulators lined with porcelain, to which were attached the wires. No glass insulators were in use. On several of the poles were shown the arrangements used at distances of about one-tenth of a mile for tightening the wires. Others represented the manner of making the connections between underground and tunnel lines, also the old and new systems of introducing wires into sta-

tions. This portion of the collection was completed by a few models of poles and of wire connections in use in Bavaria, and the exhibition of the galvanometers used by line-inspectors, and the various repairing-tools. The method of Siemens for sheathing cable-wires with gutta-percha used in 1847, and still employed for that purpose, was one of the most noticeable of the exhibits in this gallery. Of great interest to statisticians were the maps showing the development of the telegraph system and traffic in Germany since 1854.

CHAPTER II.

ADMINISTRATION.

SCOPE OF THIS PORTION OF THE REPORT; CHARACTERISTICS OF EUROPEAN ADMINISTRATION; LEGAL TELEGRAPH-CODE; STATE MONOPOLY OF THE TELEGRAPH; GERMAN ORGANIZATION; AUSTRO-HUNGARIAN SYSTEM; BELGIAN ADMINISTRATION; ORGANIZATION IN DENMARK; SPANISH ADMINISTRATION; FRENCH, BRITISH, ITALIAN, NORWEGIAN, DUTCH, PORTUGUESE, ROUMANIAN, RUSSIAN, SERVIAN, SWEDISH, SWISS, AND TURKISH ADMINISTRATIONS; RAILWAY COMPANIES AND THE TELEGRAPH; NEW OFFICES; STATUS OF EMPLOYÉS; STATISTICS OF COST, OF TARIFFS, AND TRAFFIC; CONCLUSION; TABLES OF STATISTICS.

25. INTRODUCTION.—The fine displays which were made at the Exhibition by the leading governments of Europe of the progress of those public enterprises which have been by common consent committed to their care, or with whose direction they are more intimately connected, gave to the observer an almost complete view of their actual condition in each country, so far, at least, as methods and appliances are concerned.

It is proposed in this portion of the report to go behind the material exhibits made by the different telegraphic departments, and to give such idea of actual working and results of the various systems of administration as the information which the writer has been able to collect and his observations during the short period of his stay will permit.

26. We visited the principal offices in the countries through which we passed, noticed as carefully as possible the construction and character of the lines, and made the ordinary practical tests of their operation which every traveler who sends or receives messages is compelled to make. If we were to generalize from these observations, we should say that the leading characteristics of European telegraphs, as of railways or other similar public undertakings, are the following: Permanency of construction; security and regularity in working; enterprise, economy, and efficiency in administration and management, with direct regard to their cheap and convenient use by the people.

While the lines are more expensively, because more durably, built than in this country, there has been, except in Great Britain, no exorbitant capital on which to earn interest, and no loosely-drawn contracts to enhance the apparent cost of construction. The tariffs, therefore, have been reduced to the lowest level, within the reach of all classes of citizens and applicable to all classes of correspondence. While the practical spirit of the American people has shown itself more conspicuously in the invention of improved means of transmission and

in the development of talent among the subordinate employés of the telegraph, (to whom most of the progress of the art in this country is due,) European administrations have uniformly employed a higher order of scientific ability in the more important positions, and have shown greater liberality in the adoption of improvements. Regarding the telegraph, as the mail is everywhere regarded, not as a field for speculative enterprise, but as a valuable public aid to the conduct of legitimate private affairs, European governments have sought, and with a great measure of success, to prevent its abuse and to expand to the utmost its benefits.

27. LEGISLATION WITH REGARD TO TELEGRAPHS.—Since its first introduction as a branch of the public service in Europe, the telegraph has been made the subject of a great number of laws, both civil and criminal, and of international regulations which have assumed the form of treaties, revised from time to time in conventions of properly-authorized delegates from each country. The internal legislation of the different states, which varies but little in its character, has been commented upon by many jurists in legal treatises, the best known of which is that of Dr. Dambach.

Its main objects have been to secure, (1,) the monopoly of the state; (2,) the means of establishing telegraphs and securing their protection; (3,) proper tariffs and rules; (4,) the secrecy of dispatches; (5,) prevention of their abuse.

28. With regard to these objects, it may be said generally—

(1.) That the monopoly, springing from the same reasons of public policy which direct that the carrying of the mails be confided to the government, and not being based on fiscal necessity, has been uniformly a benefit to the people. The use of a term in itself so odious is calculated to excite antipathy toward any institution to which it is applied. As has been justly remarked by Mr. Dupré, of the French administration, the only monopoly which properly deserves odium is the private monopoly, whether originating in mistaken grants from the government or the slow and imperceptible encroachment on public rights by combinations of private capital. The monopoly of the telegraph is, however, of a very mild form in several of the states. Concessions are freely granted for the erection of private wires, and wires are rented to parties requiring their use. But for the necessity of governmental supervision in time of war, it would be an interesting experiment for some European country (as, for instance, Belgium, where no application has ever been made for the establishment of private lines) to throw the telegraph open to the competition of private parties. It is unfortunate that the enormous price paid for the English telegraphs compelled the government to abandon the design, which it at first entertained, to leave the field open for competitors, and to let the people judge, upon a fair trial, of the respective merits of public and private management, both as to efficiency and economy. I do not doubt that, with equal facilities, the

government would command the greater confidence and receive the larger patronage, and the experience of American companies has shown that a competitor without equal facilities is not to be feared. Such an experiment is perhaps reserved for the Government of this country.

(2.) In the erection of lines in Europe, private rights are guarded very carefully, and indemnities paid for their slightest infringement. Such indemnities have been asked only once in the whole history of the Belgian telegraphs. The lines being generally placed along the tracks of railways, the provisions for their erection and maintenance are the subject of arrangement with the railway authorities, upon which a special note has been prepared. Stringent penalties are everywhere inflicted upon persons destroying them, or in any way interfering with their working.

(4, 5.) There are similar provisions in the criminal codes with regard to the violation of the secrecy of messages by employés of the telegraph or others and their detention or abuse. In Belgium only one case of violation of secrecy has yet occurred, while cases of crime or misdemeanor committed by aid of the telegraph, through the means of the false signature of messages, &c., have been not infrequent. To avoid participation in such unlawful acts, the administrations are given the right, which is claimed and allowed by the American companies in most of the States, to refuse such messages as are dangerous to the public peace or morals. That this right is given only to save the authorities of the telegraph from culpability and not for political purposes is evidenced by the fact that no restrictions are placed on cipher-messages. In Europe, as in America, the courts have power to require the production of messages as evidence. A libel may be committed by sending a private dispatch, because its contents are made known to the operators.

The irresponsibility of the state for errors in the transmission of messages, though subjected to much criticism, has been uniformly maintained in Europe, for reasons similar to those set forth in the message-blanks of the American companies and sustained in law by the decision in the Georgia case in 1869. The price of a wrongly-sent message may be reclaimed by the sender. In Belgium in 1871 there were one hundred and seventy-five complaints to two and a half millions of messages.

A general synopsis, even, of the regulations adopted for the telegraph, and based upon the laws thus briefly alluded to, would be entirely too long for this report. It is therefore limited to the consideration of such points in the administrative systems of the different countries as bear some analogy to the management of the telegraphs in America or some relation to the question of postal telegraphy, which has been so much agitated here. For information upon these subjects, as well as for the statistics which are appended hereto and made the text of another portion of this report, we are principally indebted to the International Bureau of Telegraphs at Berne and to its official publications. The unfailing courtesy of Mr. Curchod, the director of the bureau, and of the other

gentlemen connected with it, in furnishing data to Americans interested in the solution of the problem of cheap telegraphy on this side of the Atlantic, deserves their warmest thanks.

ORGANIZATION OF THE TELEGRAPH AND ITS RELATION TO OTHER BRANCHES OF THE PUBLIC SERVICE.

29. *Germany.*—In Germany the postal-service and that of the telegraphs form two distinct departments, and are both considered as general directions of the empire, (*Reichsland anstalten,*) subject only to the supervision of the chancellor. The autonomy of the telegraph, however, is not yet extended throughout the entire territory of the confederated German empire. Bavaria and Würtemberg have both preserved their separate administrations, which operate, especially so far as their internal service is concerned, independently of the general directions.

In Bavaria the administration of telegraphs forms a subdivision of the department of communications, which embraces the railways, posts, and telegraphs. The degree of union between these three services is much closer than in the rest of Germany. In almost all towns the post and telegraph offices are placed in the same buildings, and frequently under the same control. The smaller offices are generally in the hands of employés of the post-office.

In Würtemberg a special staff is employed, recruited principally from ex-soldiers. In only a few less imporant offices are the postal and telegraphic services united in the hands of the same person. As far as the central administration is concerned, the telegraph, the posts, and the railways form each a direction in the bureau of communications attached to the department of foreign affairs, which takes the name of "*Ministerium des Auswärtigen Angelegenheiten und der Verkersanstalten.*"

30. *Austro-Hungary.*—In Austria the telegraph has until lately been a "direction" of the ministry of commerce, together with the post-office, but by a recent decision this special direction has been abolished and its duties transferred to the minister himself. In the new organization the post and the telegraph form one section of the ministry above named, at the head of which is placed a director general under the authority of the minister. The portion of this section relating to the telegraph is divided into three parts: the technical division, the division of tariffs and of international correspondence, and the division charged with the working of the lines. For the financial part of the service, the department of accounts continues to lend its aid, both to the telegraph and to the post. In the international service the more important offices employ a special staff, but in the greater number of small places, as well as in the branch offices in cities, the telegraph is placed in the same office and under the same authority as the post.

In Hungary the direction of telegraphs is placed under the authority

of the director-general of posts and telegraphs, who is himself subject to the minister of commerce. The relations between the two services, it is believed, are much the same as in Austria.

31. *Belgium.*—The direction of the Belgium telegraphs forms one of the eight bureaus of the general direction of railways, posts, and telegraphs, under the department of public works. The points of contact between the three administrations are sufficiently numerous. Except in the principal offices, the same employé is charged with two of these services, and sometimes with all three. The post-office gives its aid gratuitously to the telegraph in forwarding telegrams, and in the smaller towns messages and letters are delivered by the same carriers. On the other hand, messages on postal service are sent free by the telegraph. The stamps used for telegrams are, however, different from those used, for letters; and in the money-order service the telegraph is only an intermediary, lending its aid to the post-office in consideration of the price of the message, and taking no responsibility. A very large number of dispatches is annually transmitted on the service of the state railways, (as well as for railways belonging to private companies,) in return for which the telegraph receives free transportation for its materials, &c., as in America.

32. *Denmark.*—The telegraphic administration in Denmark, like the post-office, depends upon the ministry of finance, but the *personnel* of each service is distinct. The only points of contact are the accepting by the telegraph-offices of postage-stamps for the payment of telegrams forwarded from places where no offices exist, (the stamps being turned over to the post-office for their value,) and in the telegraphic money-order service, the post-office receiving on telegraphic money-orders a tax of only two skillings, (one cent.)

33. *Spain.*—In Spain the telegraph forms one section of the general direction of posts and telegraphs, often styled the general direction of communications, which itself is placed under the ministry of the interior. The two services have distinct staffs in the principal offices, but in the smaller towns the telegraph is not generally employed, except in conjunction with the post-office, the municipalities furnishing the necessary offices. Neither of the two services has a financial department, their receipts being turned directly into the general treasury, by means of the sale, by agents foreign to both administrations, of stamps, which are the same for telegrams as for letters.

34. *France.*—Since the introduction of telegraphy into France the telegraph has formed a department distinct from the post-office, and belonging to a different ministry, the latter being a branch of the ministry of finance, and the telegraph depending on the ministry of the interior. The staff of each service is distinct, except in a very few of the smaller offices, where the postmaster is charged with the direction of the telegraph. In most of the small towns, however, the telegraph is confided to one of the secretaries of the "mairie," or municipal gov-

ernment, or to the teachers of the public schools. The telegraph transmits gratuitously the service-messages of the post-office, and the latter, in turn, franks the letters of the telegraphic administration, in conformity with the "franking privilege," accorded by general law to all branches of the public service, both for letters and telegrams. The telegraph also lends its aid to the post-office in the transmission of money-orders, but without responsibility, and only as an intermediary between the post-offices at the points of departure and arrival. The receipts and expenses of the two services are kept entirely distinct. For some time the telegraphic administration employed stamps for the payment of dispatches of a different kind from those used for letters, the stamps of neither administration being received by the other.

The question of a more intimate union between the post-office and the telegraph has been frequently raised. In 1865 the proposition was rejected after inquiry by a committee and a debate in the Corps Legislatif. During the latter part of the Franco-German war the two services were temporarily placed under one head, but this consolidation was not preserved after the signing of the treaty of peace. At present, however, the fusion of the two administrations under one ministry is again proposed, and is under consideration by the committee of the national assembly charged with the inquiry into the various branches of the administration.

35. *Great Britain.*—Great Britain is, perhaps, the country where the most complete fusion between the post-office and the telegraph has been established. It is the post-office which has purchased and now operates the lines formerly belonging to private companies. The services are bound together in their central direction, and their administrative limits are the same, while in the greater number of offices the postmaster is charged with the control of the telegraph. At some 2,800 offices the postmasters themselves provide for the service, receiving therefor commissions on the receipts, which average about 10 shillings per week. For this sum the postmaster provides a place for writing messages and room for the instruments and batteries. He also, unless he performs the work personally, furnishes an operator, generally a member of his family, and a messenger for delivery of the dispatches. In the larger offices the head postmasters receive for their responsibility and personal supervision allowances depending partially upon the number of messages forwarded and partially upon the number of circuits worked from their offices. The allowance cannot be less than £10 per annum, nor exceed £50, except by special arrangement. In the offices where a special staff is employed, it is made up of the old employés of the companies or of persons instructed in their duties at the several schools attached to the department. Wherever possible, however, the postal clerks and employés are taught the use of the telegraph, and the two services merged in their hands. The technical portion of the service is committed to an engineers' department, employing between five and six hun-

dred persons, among whom are many well-paid and thoroughly capable officers. The stamps used by the telegraph and post-office are identical, and the offices are generally in the same building. Each post-office is also an office of deposit for telegrams, which are forwarded to the nearest telegraph-station.

36. *Italy.*—In Italy the telegraph was formerly attached to the post-office, but the decree of September 18, 1865, constitutes it an independent general direction, belonging, together with the post-office, to the ministry of public works. The staff is distinct, even in the smaller offices, the management of which is confided, as in France, to agents of the municipalities.

37. *Norway.*—In Norway the direction of telegraphs depends upon the department of marine and of posts. The *personnel* of the telegraph-offices is generally independent of the post-office.

38. *Netherlands.*—As with the postal service, the administration of telegraphs in the Netherlands belongs to the ministry of finance. It is placed under the authority of a special officer, called the *referendaire*, charged with the direction of the telegraphs. In the offices of medium and lesser importance, including those established at the request of communes, the two services are placed in the same building and under the same authority.

39. *Portugal.*—The general direction of telegraphs and light-houses constitutes in Portugal a service distinct from that of the post-office, but the two bureaus belong to the same department, viz, that of public works. A special staff is employed, even in the smaller towns, except where, as in France, municipal agents act as employés of the telegraph.

40. *Roumania.*—In Roumania the two administrations form but one general direction, belonging to the ministry of the interior. Their organization is regulated by the same law, they have the same central administration, and, save in a few important places, their offices are in the same building and under the authority of the same person. Finally, their receipts and expenses are merged together in their accounts.

41. *Russia.*—The general direction of telegraphs in Russia is completely independent of the post-office, although both are attached to the same ministry, viz, the interior. The staff of each service is generally distinct, except in a few smaller offices. It is recruited principally among those who, by the Russian laws, are eligible to public office. In some unimportant places, however, the municipal agents, and in others women, are employed.

42. *Servia.*—In Servia the telegraph is a bureau in the department of the interior. If not completely merged with the post-office, as in Roumania, it has at least many points in common with it, both as regards the central administration and the working of its offices.

43. *Sweden.*—In Sweden the general direction of telegraphs, which comprises, in addition to the telegraph service proper, that of the semaphores or optical signals, is completely distinct from the post-office.

The telegraph-system of the kingdom is divided into two districts, each under the control of an inspector-general subject to the general director. The *personnel* of the service is distinct, the smaller offices being generally confided to women.

44. *Switzerland.*—Like the post office, the telegraph in Switzerland is placed among the attributes of the confederation, but with this difference, that, the postal service being formerly carried on by the cantonal governments, the constitution of 1848, by which it was transferred to the confederation, stipulated for certain indemnities in favor of the cantons, while, the telegraph having been from the beginning a recognized federal institution, its receipts have always been collected by the confederation. The two services are placed under the authority of the federal councilor charged with the direction of the post-office. The central administration forms a special direction, having a chief and a staff completely distinct. The administrative limits are equally separate, Switzerland being divided, with regard to the postal service, into eleven departments, and with regard to that of the telegraph into six. At the head of each of these latter is placed an inspector, whose duties relate exclusively to the telegraph. The cashier of the post-office, however, performs the same service for the telegraph in each district of the latter as for the post. The staff of the principal special telegraph-offices is completely independent of the post-office and subject only to the administration of the telegraphs or to the chief of the post-office as head of services. The offices of both are generally placed in the same building, but in separate rooms. In the smaller towns the same agent is generally charged with both functions, receiving special compensation for each service. The stamps used are distinct. The telegraph lends its aid to the post-office for the transmission of money-orders. On the other hand, the post-office franks telegrams forwarded from a postal to a telegraphic station, or *vice versa.*

45. *Turkey.*—Formerly the telegraphic administration in Turkey constituted a general direction distinct from the postal service, but this direction having been abolished toward the end of the year 1871, in consequence of measures of re-organization undertaken by the new grand vizier, Mahmoud Pacha, its functions were transferred directly to the post-office. As yet the *personnel* of the service, at least so far as the offices open to international correspondence are concerned, remains distinct from that of the post-offices.

RELATIONS BETWEEN TELEGRAPHIC ADMINISTRATIONS AND RAILWAY COMPANIES.

46. *Germany.*—All railway-stations in Germany are authorized to transmit telegrams for the public on the following conditions:

These dispatches are subject to the same rules as are applied to the governmental service. Messages relating to the service of the railways have priority over their lines. Private dispatches are not delivered at

the stations except in places where there is no governmental office, or when they are addressed to persons traveling over the railways, or when the sending and receiving stations are in the same tariff "zone" or circumscription. No railway-station is allowed to transmit messages beyond the frontier of the empire.

In all places where there are both governmental and railway offices they are connected by wire, unless they are situated very close to each other. The stations may also be connected to the nearest governmental offices in adjacent places at the expense of the administration, and the lines are worked by the agents of the state and the railway. When there is no line the exchange of dispatches is made by special messengers.

The railway companies receive for messages transmitted exclusively over their lines the entire tax. If the messages traverse in part the lines of the state, the railways receive 5 silbergroschen (a little over 10 cents) per message, without regard to the number of words up to fifty. Every fifty words or fraction thereof constitute a separate dispatch, so far as payment is concerned. Each railway over whose lines a message may pass receives its proportion of the sum allowed. For each message deposited at a railway station and sent immediately by wire or messenger to a governmental office in the same or an adjacent place, the railway company is also entitled to half the above charge for messages traversing the lines of the state and railways jointly. The same proportion of the total charge is received by the state on messages deposited at its offices and sent to the railway-stations for transmission. For delivery beyond a distance of one English mile (about one-quarter German mile) from the railway-station, the company may also charge a sum not to exceed 5 silbergroschen. For delivery at the distance of a German mile, 9 silbergroschen may be charged, and 9 more for each additional mile.

47. *Austro-Hungary.*—In Austro-Hungary the relations of the administration of telegraphs with the different railway companies are regulated by contracts, containing generally the following conditions:

No charge is made for service-dispatches of the railways (even before the completion of their tracks) upon the lines of the state. Private dispatches, sent over either governmental or railway wires, are subject to the same general regulations. The companies transmit such private messages as do not interfere with their own service in the name and for the account of the government, receiving therefor for each message of twenty words or less deposited in and transmitted from a railway station a tax of 20 kreutzers, (10 cents,) and 5 cents for every additional ten words. If, however, the message is sent for transmission to a governmental office within the same local limits as the railway-station, the former receives the entire tax of 20 kreutzers. If there is a governmental office in the same locality, the railway is not generally allowed to receive private messages, except local messages and those of travelers. These latter are subject to a charge of 20 kreutzers for the benefit of the company. If the railway delivers a message at a place where

there is a governmental office, it receives 10 kreutzers if the message contains twenty words or less, and 5 kreutzers for each series of ten words beyond twenty. The accounts are squared each month, and accepted without dispute if the difference between those of the companies and those of the government does not exceed 1 per cent.

The state has the right to establish lines along the tracks of the railways and to string its wires upon the poles of the companies. The latter pay all expenses of stringing their own wires, and also all expenses of their special lines when established, but the construction of these latter is undertaken by the state. In planting poles and the establishment of tunnel and underground lines, the officers of the government consult those of the companies. Any removal or change of wires demanded by the latter is made at their expense, but by the agents of the government. The companies have the right to establish offices in each signal or other station, notifying the government thereof. They can use such instruments for their service as they see fit, furnishing the administration with a sufficient number for the state control if another system than the Morse is adopted. Each company submits its code of signals to the approval of the administration. The staff of the former is subject to the same rules governing that of the latter, and subject to suspension or dismissal by the government. The wires may be run by the companies into their stations or signal-houses. If this work is done by the government, its cost is paid by the companies. The latter are also required to furnish their own apparatus, and may procure them at cost from the government. The surveillance and maintenance of the wires stretched by the companies upon the poles of the government is undertaken by the latter, at a charge of 15 florins (about $7.20) for the first wire and 10 florins for each additional wire. The wires upon the companies' poles are watched and maintained by their officers. The messages of the companies are subject to inspection by the government, and if found not to be on their service, are liable to a charge of one and one-half times or twice the normal tariff. In case of interruption on the lines of the state, governmental dispatches are sent free over the railway wires, and *vice versa*. The state has the right in case of war or similar emergency to suspend entirely the working of the railway-telegraphs. Superintendents and those charged with the construction of telegraphs receive permanent passes on the railways. Free passes are also given, at the request of the administration, to persons traveling on the service of the telegraph.

48. *Belgium.*—The companies operating railways in Belgium under concessions from the government have all concluded contracts with the administration of railway posts and telegraphs by which they have agreed to send messages for the public for the account of the administration and without profit to themselves. They forbid, at the same time, all free correspondence between their agents, except strictly upon the service of the railways. These contracts are all similar in their nature,

and their provisions are united in the form of general regulations issued by the administration of telegraphs.

Lines are established by the government along the railways of these companies, with such offices and apparatus as the administration may think proper. The companies may add, at their own expense, to such wires, offices, and apparatus, the material being approved by the administration. The companies are not, however, obliged to provide special wires as long as, in the judgment of the telegraphic authorities, those existing are sufficient for the service of both the state and the railway. By consent of the administration, the companies may open offices for their own use upon the wires of the state. In case the administration demands the erection by the companies of special wires for the service of the latter, the companies must comply within six months or abandon the use of the governmental wires.

Public and private messages must be received at the railway-offices. These, however, are established by the companies to suit the needs of their service. In return, railway-messages are sent free over the wires of the government, care being taken to grant no greater use of state wires to the companies than is a fair equivalent for the use of railway-wires by the state.

All dispatches relative to the railway service are sent free as far as their lines of track extend, but not beyond this, except messages upon the service of two or more railways, or those between the stations of a railway and its general office when the latter is off the line of road. To obtain the use of the state wires and apparatus on international lines, the companies must obtain the consent of the neighboring government.

The railways, like those of the state, transport free all employés and material designated by the administration of telegraphs, whether engaged in or designed for the construction of lines along said railways or not.

The repair and maintenance of the wires of either party are confided to the agents of the administration, but the material for such service is furnished, as are the instruments and office-fixtures, by the party to be benefited.

The offices used by both parties are divided into four classes, and their expenses divided according to the use to which they are subject.

The officers of the first and second classes of these *bureaux mixtes* must be kept open from 7 a. m. to 9 p. m., those of the third and fourth classes from 9 to 12 a. m. and from 2 to 7 p. m., for the reception of private messages. In each of their offices the companies designate one employé, and sometimes as many as three, to whose services the administration of telegraphs has a right during at least four hours of the day, the exigencies of the companies' service being first considered. The employés of the state in the mixed offices are required to observe the requisitions of the station-masters, with regard to the police of the station and the telegraphic service of the railways. The instruments must

be securely placed. Governmental offices kept open during the night must take messages on the service of the railroads, and *vice versa*. The administration charges itself with the instruction of the employés of the railways in mixed offices. Either party may demand the dismissal of employés of the other for sufficient cause.

Upon the wires of the state, used also by the companies, the order of messages is as follows: 1st, service-messages relating to the working of the wires; 2d, dispatches of state; 3d, private messages; 4th, ordinary service-messages. On special railway-wires messages on railway service take precedence of those on private business.

Private messages must be written upon the blanks of the administration and forwarded within a certain time to its central office. All other messages are registered in books kept for that purpose. subject to inspection by the officers of the administration. In mixed offices of the first and second class, messages are delivered by the administration, and at its expense; in those of the third class by the companies, at their own cost; and in those of the fourth class by the companies, at a charge to the administration of 4 cents per message. In mixed offices of the second, third, and fourth classes 6 cents per message is allowed to agents of the companies for each private message sent or received up to the first hundred in any six months, and beyond the first hundred the charge is 2 cents, the total of such allowance, however, not to fall below the sums received for such service before the 1st of January, 1866, (date of the 50 per cent. reduction of tariffs in Belgium.)

No responsibility is assumed by the administration for damages resulting from the fault of its agents in transmitting messages on railway-service, nor by the railways for those which may result from the fault of their servants in sending messages for the public.

These regulations have for their principal object the fusion of the governmental and railway telegraphs into one system, of which the government shall have a general supervision, and over which the dispatches of the state, the public, and the railways may circulate freely, without other distinctions than those necessary for their efficiency. In one word, the state and the railways form an association with the design of providing, at common expense and as regularly and economically as possible, for all classes of telegraphic correspondence.

49. *France.*—In France the railway companies can only establish lines of telegraph by virtue of concessions from the government. These concessions have been made the objects of successive acts for each particular company. It has been the intention of the administration to unite the provisions of these acts in one general regulation, but so far this has not been done. The following are, however, the principal of these provisions:

The state has the right to build lines along the tracks of the railways. The wires of the companies placed on the poles of the government must not interfere with the service of the latter. All expenses of construction

of the special wires of the companies are borne by them, but the work is done under the direction of the officers of the government. The telegraph-offices in the railway-stations are required to be easily accessible to the public. The state has the right to establish in every station where it may think proper an office controlled by itself. In such offices the employés of the state perform the telegraphic service of the railways, and their salaries and their indemnities for night-service, &c., are paid by the latter, according to their grade.

The companies have the right to transmit free all messages relative to their service, which messages are registered, as in Belgium.

The companies furnish the director of telegraphs with lists of their agents authorized to use the telegraph. Their dispatches are sent in the order of deposit, unless the order is changed by the station-master. At all stations governmental messages have priority, and dispatches of the companies take precedence of private messages.

The companies furnish the instruments and batteries in offices operated by the employés of the state. The inspectors of telegraphs are charged with their maintenance. Agents of the government employed in the stations, although paid by the companies, are subject only to the orders of the administration. Their salaries are first paid by the latter and re-imbursed to the treasury annually by the companies. Passes are granted to the officers and employés of the telegraph on presentation of letters signed by the director. The companies also transport free all materials necessary for the construction or maintenance of lines.

With regard to the transmission of private messages, most of the stations are thrown open to the public on the following conditions: Upon messages to be delivered from railway-stations, they are entitled to charge the sender 10 cents, if the addressee resides within one kilometer (about three-fifths of a mile) from the station, and 10 cents more for each additional kilometer. They also receive a rebate of 40 per cent. upon the amounts received for telegrams by their station-masters and turned in to the treasury, so that the administration receives only three-fifths of the moneys taken in for messages at the railway-stations.

50. *Great Britain.*—By article 9 of the telegraph act of 1868, the post-office acquired the perpetual right of way (the railway companies consenting) for the erection of its lines along the tracks of the railways, the right to place its wires upon the poles of the companies, and the right for the public to transmit messages over the wires of the companies.

The conditions upon which these rights have been obtained rival in their extraordinary character those exacted by the telegraph companies for the purchase of their lines, which, it will be remembered, as soon as their sanctions by Parliament became known, caused an advance of from 100 to 200 per cent. in the market-value of their shares.

All wires belonging to the telegraph companies which had been used for railway-service were bought by the government and turned over absolutely to the railways. The railways retained those wires which

were their own property, and were given the right to place others upon the poles of the government. The companies have the right to displace the lines of the government, if the service of the railways requires it, and at the expense of the government.

As indemnity to the railway companies, the post-office pays—

a. The amount of twenty years' net profit (if there be any) on messages heretofore sent by the railway companies for their account, calculated on the basis of the profit for the year preceding the 1st of July, 1868.

b. Twenty times the annual increase of said profit, calculated upon the basis of the average increase for the three preceding years.

c. The rents and other payments annually payable to the railway companies by the telegraph companies during the unexpired terms of their respective contracts, and upon the conditions embraced in said contracts.

d. Such sums as may be agreed upon or awarded for the loss by the railway companies of the right of granting new ways or making new arrangements with telegraph companies, and also on account of the monopoly conceded to the postmaster-general.

e. Such sums as may be agreed upon or awarded for the reversible interests (if any) of the railway companies, in the receipts of the telegraphs from private messages at the expiration of the contracts with the respective telegraph companies.

f. Such sums as may be agreed upon or awarded for the loss occasioned by the dismissal of clerks actually paid by the telegraph companies, and by all extraordinary expenses incurred by the railways in working its own telegraphs, by reason of the separation of the two systems.

g. The postmaster-general is to transmit, free of charge, to their respective destinations throughout the United Kingdom, all dispatches relative to the service of the railways.

h. In consideration of its perpetual right of way, the post-office must pay annually to the companies such sums per mile and per wire as shall be agreed upon or awarded.

The arbitrator, in determining the sums to be paid to the railways under the above stipulations, must take into consideration the contracts formerly existing between the railway and telegraph companies and the fact that the cession was obligatory upon the companies.

The companies accept dispatches for transmission over their lines or over those of the state. Over the former, however, their own messages have priority. On each private message sent over the wires of the company or by the company's employés over the wires of the Government, or both, 3*d.* is paid to the company. On each private message received by the lines of the company and delivered by it within a radius of one mile from the station, 3*d.* is also paid; if delivered at a distance of from one to two miles, 9*d.*; two to three miles, 1*s.* 3*d.*; and beyond three miles,

6*d*. per mile. For press-dispatches the companies receive 3*d*. per hundred words or fraction thereof. If the companies undertake to transmit press-messages or others outside of their ordinary hours of service, they may charge a moderate additional tax, explaining to the senders that such charge is for the benefit of the railway. The accounts must be stated weekly by the companies and paid quarterly by the post-office. Messages on the service of the post-office are sent free over the railway-wires, and must be delivered free within a radius of one mile.

All of these arrangements were made subject to revision five years from the date of the transfer of the telegraphs to the state. Large claims have been made against the post-office under the stipulations entered into with the companies, and the cost of the telegraphs to the state, already exceeding threefold their cost to the companies, will probably be further increased.

51. *Italy*.—In Italy, as in France, the relations between the telegraphic administration and the railways are regulated by the terms of the different contracts existing between them.

Generally the lines along the tracks are built by the state, according to the plans adopted for its own system. The state also reserves the right to remove lines run on the highways to the line of the railways.

The companies are given the use of one or more wires, according to the exigencies of their service, as well as the right to establish such number of stations as they may think fit. The state reserves the right to install in the stations officers of its own, the room being furnished by the companies. To aid the construction of lines, the companies pay to the state generally 100 francs per kilometer of line and 75 francs for each kilometer of galvanized wire. The state and the companies procure, each on its own account, the instruments and material necessary for its service. The companies transport free the employés and material of the administration. The state maintains the lines, the companies contributing annually 8 francs for the first and 5 for each subsequent wire set apart for their service. The companies may open stations for the public, informing the administration ten days in advance of its intention to do so, and close them by giving fifteen days' notice. The state reserves the right to suspend totally or in part the transmission of private dispatches over the wires of the companies. The companies cannot transmit private messages between points where there are governmental offices, except in case of interruption of the state wires.

The administration receives 20 per cent. of the tax on all private messages sent by the companies to Italian offices, all the receipts for governmental messages, internal or international, and the international tax on all private messages sent beyond the frontier. Dispatches on the service of the telegraph are exempt from all charges, and those on the service of the companies are sent free on the governmental lines. Accounts are squared every three months.

The stations of the companies can only correspond with foreign sta-

tions through the intermediary of a governmental office. The state reserves a permanent right of control for the execution of all the conditions of the contracts.

52. *Switzerland.*—The federal law of 1872 relative to the establishment of railways in Switzerland contains the following article:

"ARTICLE 9. The following obligations are imposed upon railway companies, for which no indemnity will be granted:

"*a.* To permit the establishment of telegraph-lines along their tracks;

"*b.* To superintend and conduct, through their engineers, the work of first establishment and the heavier repairs thereof; and

"*c.* To employ the staff of the railways in watching the lines and in the lighter repairs, for which the administration of telegraphs furnishes the materials."

These conditions are reproduced in all the concessions made by cantons to the different railway companies, as without them the sanction of the confederation, necessary for the validity of the concessions, cannot be granted. In addition, the administration of telegraphs has concluded with the different companies at the date of their establishment, contracts regulating the transmission of private messages over the wires of the companies. These contracts were revised in 1867 and submitted to a general convention, in which all of the companies participated. The reduction of the internal tariff on messages from one franc to half a franc having been determined on by the telegraph authorities, and it being necessary, in order to make such reduction, to diminish the commissions paid to the railway companies, an agreement was reached, of which the following are the principal conditions:

The railway-stations may act either as offices merely of deposit for telegrams or as offices for their transmission, reception, and delivery.

Space may be rented in the stations to the administration of telegraphs for the establishment of special and independent offices.

The right of the companies to preserve their wires and offices solely for their own service, giving the use of them to the public only when it may be done without injury to their own interests, is conceded, as is also the priority of messages on railway-service, which may even interrupt the transmission of private dispatches.

The instruments used in the stations for the transmission of private messages may be furnished either by the administration or by the companies, and in the latter the administration will pay the sum of 25 francs for their annual maintenance.

Should a company, at the request of the administration, throw open all its offices to the public, the administration will furnish, if desired, a second wire for the use of the railway, the latter to bear the expense of putting the same in place and furnishing the necessary instruments.

The following indemnities will be paid the railway companies:

For offices of deposits: 50 centimes per message sent by hand to the governmental office, and 25 centimes per message sent by wire to the same.

For offices of transmission and reception: 25 centimes for each paid message received or sent, in addition to express-charges, if there be any.

Railway offices open for the transmission of private messages will be connected to governmental wires and treated as intermediate offices of the government.

Accounts will be squared each month. All private messages will be sent to the central office at Berne. The original paper strips of received messages remain with the railway companies, subject to inspection for verification.

The offices of deposit will explain to senders of messages that to escape the payment of the extra charge they should take them to the governmental office.

The offices of deposit are kept open from the time of the departure of the first train in the morning to that of the last train at night.

All rules for the government of the operating-force in governmental offices, especially those relating to the secrecy of messages, are extended to the railway-offices. The subordination of the latter to the railway officials is, however, to be preserved.

ESTABLISHMENT OF NEW OFFICES.

53. *Germany.*—The establishment of telegraph-offices in the smaller villages of Germany is authorized only upon the guarantee by the municipalities of all expenses of establishment, maintenance, and operation. A request must be addressed to the superintendent of the telegraphic district in which the place is located. The administration determines to which governmental office the connecting-wire shall be run and fixes generally its course. The commune is charged with securing the consent of the authorities or individual proprietors for the planting of poles upon their lands; if, however, the lands belong to the state or to railways, the administration makes the necessary arrangements. The communes may furnish, subject to the approval of the administration, the materials for the establishment of the line and of the office, or they will be furnished by the government at the cost of the communes. The instruments are always provided by the administration. The maintenance of the lines and office is at the charge of the commune, in conformity with the regulations of the state.

The communes nominate and pay the operators, who cannot, however, enter upon their duties without the approval of the government. Their instruction takes place in such offices of the state as may be designated by the latter, but at the expense of the communes. The rules of the administration are extended to the municipal offices, which are under its control and supervision. The tariffs are the same as those of governmental offices in the same tariff-zone The tolls received are turned over to the connecting governmental office, after deducting 5 silbergroschen ($12\frac{1}{2}$ cents) for each message transmitted, without regard to

the number of words. The delivery of received messages is part of the expense borne by the commune.

The administration reserves the right to purchase the establishments of these communal offices by the repayment, in five yearly installments, of half the expense incurred by the commune in their first institution, and in the instruction of the operator. From the first payment the commune loses the right to make any change in the organization of the office, and from the fifth the entire establishment becomes the property of the state. The administration retains or not, at its pleasure, the operator employed by the commune.

The administration has at all times the right to close, to operate through its own employés, or to bring under its own constant control the municipal offices, especially in the case of abuse in their management or in time of war or internal troubles. In the latter event, the offices are immediately incorporated with the governmental system, the administration being charged with the payments above mentioned. In case of the temporary substitution of agents of the administration for those of the commune on account of mismanagement of the latter, the expense is borne by the communes. Should the office be definitely taken possession of by the state, the commune must pay the salary of the operator of the state during the five years fixed for the purchase, as well as the cost of maintaining the line.

54. *Austro-Hungary.*—The administration requires of municipalities desiring the establishment of offices in localities where the traffic would not authorize their being opened by the government that they furnish room for the office and for the operator and fuel for the former. The communes must also guarantee an annual sum of 400 to 500 florins, in case the receipts do not reach that figure.*

55. *Belgium.*—The telegraphic facilities in Belgium surpassing generally the real necessities of correspondence, the department of public works has adopted the following uniform rules:

Not to open a telegraph-office where there is neither a post-office nor a railway-station, and where, therefore, the government has neither room, staff, nor means of receiving money.

To extend its lines to all places where there are post-offices when the postal receipts exceed 2,500 francs per annum, provided such office be more than five thousand meters (say two and one-half miles) from a telegraph-office.

To admit private messages to all stations of the state or conceded railways furnished with instruments for the use of the railways.

These rules guard the treasury and preserve the service from super-

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*This arrangement approaches more nearly that adopted by the companies in America, and is evidently less advantageous to the villages than the German plan, as the communes (or in America the citizens) take the risk of the receipts falling short of the expenses, but do not share in the profits in case the former exceed the latter nor do they retain any interest in the office subject to purchase by the telegraphic authorities.

fluous complications. Private parties may establish telegraphs of their own, but could not operate them without paying certain tolls which would have to be fixed by law. No application has as yet been made for permission to establish such lines, the system of the state more than satisfying all the necessities of correspondence.

56. *France.*—In the general development of the telegraph in France, all places of importance have been supplied with telegraph-offices by the government. The smaller villages which desire the opening of offices are required to furnish the room or portion of a room separated from other portions and easily accessible to the public. The expenses of installation and of office-furniture and repairs of the same are borne by the commune, as well as those for fuel and lights. The telegraphic apparatus and material are furnished by the government, which preserves its property in them, and keeps them in working order. The operator is nominated by the mayor and approved by the administration, which allows him a commission of 15 centimes per message sent and 20 centimes per message received and delivered. If the operator holds a position with a fixed salary, the commissions are added to it.

Certain private offices are also established (at factories, forges, &c.) under the same conditions, with this exception, that the instruments are furnished by the "concessionary," and that the operator receives no commission on messages. The state remains proprietor of the lines, inasmuch as it furnishes the material for their construction, and main tains them at a fixed yearly charge per kilometer. The offices of this category are connected only to principal or secondary offices of the government. The concessionary turns into the treasury every month the amount received for messages, at the ordinary rates of tariff.

57. *Great Britain.*—The notes upon the relations of the telegraph to the post-office and to the railway companies give nearly all necessary information upon the subject of the establishment of offices in the smaller towns in Great Britain. The administration designs making the telegraph co-extensive with the post-office, and receives no aid from the local authorities.

58. *Italy.*—In Italy, communes desiring the establishment of a telegraph-office must make the request, through the local magistrate, of the administration of telegraphs. This request must be made by vote of the council, and approved by the provincial deputy, and must be accompanied by the acceptance of the following conditions:

The commune agrees to pay, in advance, the sum of 300 francs for the expense of installation, and must furnish the room if it is impossible or inconvenient to locate the office in the residence of the employé.

The commune nominates to the administration one of its local officers or any other person (women may be employed) proper to act as operator. In case such nomination is approved, the administration charges itself with his or her instruction in such governmental office as it may think fit. The commune may, by agreement with the operator, receive the

portion of the tax for messages which is allowed him, paying him a reasonable compensation. The administration remits each month to the operator or to the commune 60 centimes for each private message sent, until the sum of 600 francs per annum is reached, when the commission is reduced to 20 centimes per message. The operator must provide for the delivery of received messages and for all the expenses of the office, which he may establish in his house, having due regard to the secrecy of messages.

The commune also agrees to make an advance payment of 100 francs per kilometer of line for the furnishing of posts and wires, and of 20 francs for the expense of putting them up; also an annual payment of 10 francs for the renewal of poles. These payments are not required when the commune itself furnishes the poles for construction and renewal at the time and place designed by the inspector of telegraphs.

A further payment of 30 francs per annum is exacted for surveillance of the line, except when the commune undertakes the same at its own cost. The conditions with regard to the construction and maintenance of lines are not, of course, exacted when the office is situated upon a line already built.

59. *Switzerland.*—In Switzerland, telegraph-offices are opened in all places where the importance of the traffic justifies or the interests of the state demand their establishment. Such places agree to furnish contribution to aid in supporting the expenses for the period of ten years from the opening of the respective offices, as follows:

(1.) According to the circumstances and in just proportions, all or part of the poles necessary for the construction of the special wires must be furnished by the commune, or else a sum of money paid in lieu thereof.

(2.) An annual contribution is made of not less than 100 francs.

(3.) Office-room connected with the post-office must be furnished, or a sum of money paid in lieu thereof.

The federal council reserves the right to suppress the communal lines or offices in case of failure of the communes to comply with any of the above conditions.

The operators in the smaller offices receive, according to the amount of business done, regard being had to particular local circumstances, a fixed salary of 100 to 200 francs per annum, to which are added commissions of 10 centimes on each message received or sent, excepting dispatches on the service of the postal or telegraphic administrations, the operator being charged with the delivery of messages within the free limits. The salaries of operators at these offices are subject each year to revision by the federal council. When a new office is opened in a place where there is or is not a post-office, an examination is held by the inspector of applicants for the place of operator. When the place is given to an agent of the post-office, he must provide for his telegraphic instruction.

APPOINTMENT, PROMOTION, REMOVAL, AND RETIREMENT OF EMPLOYÉS.

60. *Germany.*—The telegraph being one of the political institutions of the empire, subject to the imperial chancellor, the legal status of its officers and employés is regulated by the general law of March 31, 1873, applicable to all imperial administrations.

The *personnel* is generally recruited from among ex-soldiers, except in some cases, where an agent is allowed to employ members of his own family as auxiliaries. The appointments are regarded as made for life, unless the appointee is discharged for violation of the rules or at his own request, or promoted, or rendered unfit for service, in which latter case he is entitled to a pension.

The discipline for violation of the rules consists in. 1st, the notification; 2d, the reprimand; 3d, the apology; 4th, the temporary suspension; and 5th, the discharge.

Each chief of service has the power to inflict the first two of these punishments upon his subordinates. The dismissal must be preceded by an inquiry, of which written notes are taken, and in which the accused is entitled to attempt his justification. The sentence must be rendered by the chief of the administration. The employé has the right of appeal in the first instance to the disciplinary tribunals and thence to the disciplinary court. The disciplinary tribunals or chambers instituted for all branches of the public service are composed of seven members, the disciplinary court of nine. They form an administrative court, having jurisdiction of all violations of discipline. The Emperor has the right to set aside or mitigate the punishments decreed by these tribunals. Promotion in the telegraphic corps is regulated by the choice of the superior authorities. The pensions of employés retired after fifteen years' service amount to one-fourth of their annual salary; after thirty years' service, they receive one-half; and after fifty years, three-fourths. These pensions are paid from a fund accumulated by retaining a percentage on their yearly pay, which ranges from 1 per cent. on salaries of $300 to five per cent. on $5,500. In Baden, when the telegraph was controlled by the authorities of that duchy, pensions could not exceed $170 per annum.

61. *Austro-Hungary.*—The conditions of appointment, &c., in Austria and Hungary differ somewhat from those in Germany, but precise data with regard thereto are not at hand. In the matter of pensions the laws are more favorable than in any other country. On leaving the service voluntarily, or by reason of any change made in the administration, the employé who has seen less than ten years' service receives a sum as indemnity varying from one to one and a half years' pay. If he so leaves after serving from ten to fifteen years, he is entitled to a pension for life amounting to one-third of his annual salary. For fifteen to twenty years' service his pension amounts to three-eighths of his pay; twenty to twenty-five years, one-half; twenty-five to thirty

years, five-eighths; thirty to thirty-five years, three-fourths; thirty-five to forty years, seven-eighths; and more than forty years, the whole. Leaving at any of these stages, he may receive two years' pay at the last annual rate, by way of indemnity and in lieu of a pension, if he prefer.

62. *Belgium.*—Candidates for positions in the Belgian telegraph service must fulfill the following conditions:

(1.) Be of Belgian nativity.

(2.) Be not less than seventeen nor more than twenty-five years of age. (Ex-soldiers recommended by the war department, and counting at least eight years of active service, are admitted up to the age of thirty.)

(3.) Be exempt from disease or infirmity.

(4.) Have satisfied the militia and civic-guard laws.

(5.) Be able to give security for 1,000 francs.

These conditions apply only to the special telegraphic staff. They are not required in the smaller offices, whose agents are recruited among the employés of the railways. The union under one direction of the post-office, the telegraphs, and the railways gives great facilities for this combination of service.

There is instituted at the general direction of these three services an administrative council, presided over by the director-general, and composed of inspectors-general and chief officers, to which all questions of promotion or discharge are referred. According to the grades, these promotions or discharges are decided by the minister, the director-general, or the director.

The granting of pensions is regulated by general law. Percentages retained from salaries supply the fund from which the widows' and orphans' pensions are drawn. Invalids after ten years' service, those suffering from infirmities caused by service after five years, all employés injured in the line of duty, all who have been in out-door service for twenty-five years and are fifty-five years of age, and all who, being sixty years of age, have seen thirty years of service, are entitled to pensions which for every year of service amount to one sixty-fifth part of their average salaries for the past five years. For injuries an additional one-fourth of the salary may be added, and for extraordinary devotion one-third.

63. *France.*—In France the organization of the staff is fixed by the head of the state. The administration is composed—

(1.) Of one director of administration, nominated by the chief of the state and subject to the authority of the minister of the interior.

(2.) Of four inspectors-general; twelve division-inspectors divided into two classes; eighty inspectors, divided into four classes; forty subinspectors; ninety-two heads of principal offices, divided into two classes, who are nominated by the minister upon the presentation of the director of the administration.

(3.) Of chiefs of stations, (two classes,) principal clerks, translators, storekeepers, operators, (five classes,) supernumeraries, chief watchmen, watchmen, (three classes,) and carriers, (three classes,) in sufficient numbers for the needs of the service. These latter agents are nominated by the director of the administration.

For admission to the service as supernumerary, an examination of the different candidates is held, and the order of their admission is fixed by the examining-board. This admission is attested by a nomination delivered by the prefect of the department.

Promotion takes place in regular order from class to class and from grade to grade. The salaries are as follows:

Supernumeraries, unpaid.

Operators, (five successive classes,) 1,400, 1,600, 1,800, 2,000, and 2,400 francs per annum.

Principal clerks, 2,500 francs.

Chiefs of stations, (two successive classes,) 2,600 and 2,800 francs.

Directors of transmissions, (two classes,) 3,000 and 3,500 francs.

Sub-inspectors, 4,000 francs.

Inspectors, (four successive classes,) 5,000, 6,000, 7,000, and 8,000 francs.

Division-inspectors, (two classes,) 9,000 and 10,000 francs.

Inspector-general, 12,000 francs.

The storekeepers, mechanicians, chief watchmen, watchmen, and carriers, are outside of this line of promotion.

No one can be transferred to a superior class or promoted to a higher grade if he has not served at least two years in the class or grade immediately below for each class of the grades of operator, principal clerk, chief of station, and subinspector, and one year for the others.

The agents may be temporarily relieved (*mise en disponibilité*) by the minister, on the proposition of the director, for sickness or other cause requiring cessation of work for more than six months.

The punishments applicable to the agents and employés of the administration are, 1, notification; 2, reprimand; 3, suspension, during three months at most; 4, suspension for one year or more; 5, dismissal. The third and fourth of these punishments are accompanied by loss of the entire salary.

These punishments are applied by the minister to employés appointed by him; in all other cases they are administered by the director. A consulting commission, composed of inspectors-general, with a secretary nominated by the minister, advises with him upon suspensions and dismissals. Appeals may be taken to the council of state, which, under the law of December 20, 1864, has supreme jurisdiction of such questions.

Pensions in the French service are regulated by the general law of 1853. Percentages are retained from salaries on occasion of appointment and of leaves of absence for more than fifteen days, except in cer-

tain cases. The laws are not so favorable to the employés as in other countries.

64. *Great Britain.*—The *personnel* of the British administration is composed, as already stated, partly of employés of the post-office, partly of the old employés of the telegraph companies, and partly of those newly appointed.

The new appointments are made from candidates of either sex who have passed through the telegraph-schools established in London and other cities, and been subjected to examination in the course prescribed. Over one thousand persons have taken this course, most of whom have received appointments. The rules of admission to the schools require the pupils to be from fourteen to eighteen years of age; not more than eight male and twelve female pupils are admitted at a time; examinations are competitive; the pupils are required to write from dictation, copy statistical tables, know the rules of arithmetic and the geography of the United Kingdom, and possess good eye-sight and hearing. The number at any time must not exceed twenty males and thirty females. If after a month's probation they seem likely to fall short of the necessary requirements, they must retire from the school.

Dismissals are made by the department, officially notified to the staff, and are made generally for violations of the rules or of discipline.

With regard to pensions, the telegraph act provided that any person who, at the time of the purchase of the lines from the companies, had served five years with the companies, should, unless offered a position in the postal service equal in his own judgment, or, in case of arbitration, in that of the recorder of London, to that he then held, be entitled to a pension during life of two-thirds his annual salary, diminished by one-twentieth for every year less than twenty spent in the service of the companies. If he entered the postal service, the years of his service with the companies should be counted in the time necessary to entitle him to a pension from the government. Persons already in the postal service receive pensions of one-sixth of their salaries if retired at the end of ten years' service, and an increment of one-sixtieth for every year beyond ten, up to two-thirds for forty years' service. If the employé is retired on account of injuries received in service, then the pension is doubled.

65. *Italy.*—The *personnel* of the Italian administration of telegraphs comprises a director general, (at 8,000 francs;) four chief inspectors, (7,000 francs;) ten directors of circumscriptions, (5,000 to 6,000 francs;) inspector, (from 3,000 to 4,000 francs;) operators, (from 1,500 to 2,500;) pupils, and clerks.

Admission to the service is granted after an examination. None are admitted except Italians under thirty years of age and enrolled in the second section of the military contingent or else exempt from service. A recent examination for additional inspectors of low grade required them to show diplomas as engineers, and to pass a satisfactory examin-

ation in mathematics and French, and to show some knowledge of English and German.

All agents, down to the grade of operators, are named by royal decree.

Promotions are made one-third according to priority and two-thirds by choice. The director-general has an administrative council, whose advice is asked upon all questions touching the staff.

Punishments consist in demerit-marks, apologies, suspensions, and dismissals. The two latter sentences are pronounced by the authority nominating the agent, upon a report of the chief of administration or of the minister, according to the case.

Pensions are granted from moneys retained from salaries. Service of from ten to twenty-five years entitles the employé, in case of receiving an injury or of leaving the service, to an indemnity of 2,000 francs or less. After twenty-five years' service he may receive a pension.

66. *Switzerland.*—The telegraph in Switzerland forms a bureau of the department of posts and telegraphs, under the authority of a director and assistant director. The system is divided into six *arrondissements*, at the head of each of which is placed an inspector, having also an assistant. In each *arrondissement* there are a number of offices which are, according to their importance, served by special staff or by postal employés, or by such other federal agents as may be convenient. In the larger offices, where there are several operators, one of them is designated as chief of the office and charged with its direction.

The salaries are as follows:

Central administration.

	Francs.
Director-general	6,000
Assistant	4,000 to 5,000
First secretary	3,500 to 4,200
Second secretary	3,000 to 3,800
Controller	4,000 to 4,500
Revisers, each	3,200 to 4,000
Clerks and aids, (maximum)	3,200

Arrondissements.

Inspectors	4,500 to 5,500
Assistants	2,000 to 4,000
Chiefs of bureau	2,000 to 4,000
Operators, (maximum, comprising provisions)	3,200
Operators in way-offices	200 to 400

The federal council is authorized to allow, in the interest of the service, provisions to the operators.

All above-named agents are named by the federal council for a term of three years, at the commencement of each legislative session. The

subordinate employés, carriers, office-boys, &c., are appointed by the post-offices, for no fixed time.

The nominations are made after the examination of the candidates. Employés who have been three years in service are, at the end of that time, considered as competing as of right for re-appointment, unless they voluntarily resign, and in practice they are always re-appointed, except in the very rare cases where there are grave complaints against them.

When a vacancy occurs in the interval of three years, the vacant place is immediately thrown open to competition, and the appointment is made under the same conditions for the rest of the three years; the employé of the administration having the greatest claims on account of merit and length of service being generally appointed.

Admission to the service can only be had through an apprenticeship and an examination, of which the results are stated in the delivery to the successful candidate of his appointment.

The federal council has the right to dismiss an agent if he shows himself incapable or commits grave faults. Appeal may be taken to the federal assembly. The dismissal of subordinate employés belongs to the department of posts and telegraphs, with recourse to the federal council.

The chief of the department of posts and telegraphs, the director of the administration, and its inspectors of arrondissements have also the right to suspend temporaily from his functions an employé who is subordinate to them, under the condition of advising the superior authority immediately.

67. *Russia.*—In Russia, formerly only those entitled by law to hold public office were allowed to enter the telegraphic service. Now all classes are admitted, with the right to promotion and to a pension after twenty years of service. In 1864 women were admitted to the service, on condition of being at least eighteen years of age and unmarried or married to employés of the administration. They are examined in arithmetic and geography, and the Russian, German, and French languages. Operators understanding English receive from $160 to $240 more than the others. Those understanding the Hughes instrument are also paid from $80 to $120 more per annum than the rest. Women form about 30 per cent. of the employés, and their employment has given satisfaction, as in Austria, England, and elsewhere. They are not, however, liable to promotion, nor do they receive pensions. Invalid pensions amount to one-third the salary after from ten to twenty years' service, two-thirds after from twenty to thirty years, and beyond that to the whole. Retiring pensions, after twenty-five years' service, vary from $34 to $340 and from $68 to $680 after thirty-five years.

68. *Statistical tables.*—I append a table (No. 1) prepared with great care from official statements, and showing, so far as figures can do so, the actual condition of the telegraphic systems of Europe and the United States in 1872. Another table (No. 2) shows the large increase in business following immediately upon any sensible reduction of tariff, and an-

other (No. 3) the extent to which the telegraph is used in Europe for social and private affairs.

The figures given for the United States in Table No. 1 are taken from the report of the Postmaster-General for 1872. Their accuracy having been questioned, I have made careful investigation, and find that if they err at all, it is on the side contrary to that toward which they were accused of leaning.

The cost of the telegraph-lines in almost all of the European countries up to date is known and given in the table. When, as in Italy, England, Turkey, Roumania, and Servia, their cost is not given in the official reports, it has been calculated upon the average of continental countries, a mile of line with one wire being assumed to cost four times as much as a mile of additional wire strung upon poles already standing. In view of the cheapness of wire and the scarcity of poles in Europe, and the expensive treatment which the latter frequently receive before being used, the proportion is nearly correct. If applied to the American lines at present, however, it would not hold, owing to the large increase in the cost of wire within the past few years.

The cost of lines being an important factor in the problem whether the Government should undertake the telegraphing of the country and build its own wires or put in force the law of 1866, under which the companies have, for a consideration, agreed to yield up their own wires whenever the Government desires to purchase, some authorities are here cited upon the subject, which, if they do not agree, will at least show that the figures of the Postmaster-General, which are here adopted, are on the safe side.

(1.) In his history of the electric telegraph, published in 1866, Mr. George B. Prescott, electrician of the Western Union Telegraph Company, says that $61.80 per mile of wire (without distinguishing between single-wire line and additional wires) "is about the cost of a majority of our lines." On this basis, the lines existing in 1872 would be worth $10,197,000. But the mileage of additional wire on the same poles having increased since 1866 in much greater proportion than the mileage of single-wire line, the average of $61.80 should be much reduced.

(2.) In 1868, General Anson Stager, the general superintendent of the Western Union Telegraph Company, made a return, under oath, of the value of their property in Ohio, to the commissioner of telegraphs for that State, in which the lines are shown to be worth $35 per mile of wire. At this valuation, the 165,000 miles of wire would be worth $5,775,000.

(3.) In 1870, Mr. Charles M. Stebbins, a well-known telegraph builder and owner, said, in a sworn statement sent to a special committee of the House of Representatives:

"In regard to the cost of the lines with which I have been connected, I can give the cost only of such lines as I built or was concerned in building, viz:

"Four hundred miles from Saint Louis to Saint Joseph, including mast-crossing of the Missouri River, one-wire line, cost about $60 per mile.

"Eighty miles from Booneville, Mo., to Brunswick, Mo., including mast-crossing of the Missouri River, cost about $60 per mile, one-wire line.

"Eighty-five miles from Kansas City, Mo., via Leavenworth, Kans., to Saint Joseph, Mo., including mast-crossing of Missouri River, about $65 per mile.

* * * * * * *

"Before the war a good single-wire line could be built in almost any of the Western States at from $50 to $60 per mile, and additional wires cost from $20 to $30 per mile. I never built lines in the Eastern States, but suppose the expense would have been from fifteen to twenty-five per cent. greater, owing to extra care required in building through the streets of so many villages and along so many rows of shade-trees as line the roads in older-settled countries. I have to-day received a circular from the Washburn and Moen Manufacturing Company, perhaps the largest wire-makers in the United States, quoting the best galvanized telegraph-wire at 9 cents. That is only a trifle higher than it was before the war, and it will very likely go down to a lower figure in a short time, so that telegraph-lines can be constructed as cheaply as before the war.

* * * * * * *

"Among others, they, the Western Union Company, bought the Missouri and Western stock, paying some cash and some stock. They also built, in partnership with myself, the Pacific Telegraph from Brownsville, Neb., to Salt Lake City, Utah, some one thousand one hundred miles, (Congress gave this line $40,000 per annum for ten years, in all, $400,000, as a bonus,) which cost, by considerable financiering on the part of two of the Western Union directors, $147,000. Upon this expenditure they issued $1,000,000 of stock.

"This $1,000,000 of Pacific Telegraph stock (prominent men of the Western Union Telegraph Company being the sole owners) was afterward taken into the Western Union Telegraph Company by issuing therefor $2,000,000 of Western Union Telegraph Company's stock. After this the Western Union Telegraph Company's stock was *tripled*, by which manipulation an original expenditure of $147,000 (and a part of that not honestly spent) came to represent $6,000,000 of Western Union Telegraph stock."

(4.) In his report for 1869 the president of the Western Union Telegraph Company states that in the three years preceding the date of the report $1,238,870 had been disbursed for the construction of new lines, also that during that period the company erected 7,968 miles of poles, on which were strung 18,127 miles of wire. Had the company paid $120 per mile, the estimate of the Postmaster-General, the 7,968 miles

of single-wire line would have cost $956,160, and at $30 per mile the 10,159 miles of additional wire would have cost $304,770, which gives a total of $1,260,930, or over $20,000 in excess of the sum actually paid, (a margin certainly sufficient for equipment.) On this basis the lines would cost $11,880,000, as stated in the table.

Had the proportion of cost between the single-wire line and additional wire embraced in the company's report for 1869 been as three to one, instead of as four to one, the former would have cost $112.50 and the latter $37.50, and the lines of the country $11,962,500. Had it been as two to one, or $100 to $50, the lines of the country would be worth $12,100,000.

(5.) In 1872 Mr. Charles T. Chester wrote the following letter to the Postmaster-General:

"NEW YORK, *November* 7, 1872.

"SIR: I have the honor of presenting to you estimates for building telegraph-lines throughout the United States. It is difficult to give great accuracy to the estimate of so large a construction through such a vast extent of territory, embracing such variety of climatic influence, transportation facilities, and industrial resources. Wire, the most expensive element of construction, is at present, owing to the enormous increase in value of coal and labor in England, more than 30 per cent. higher than it was six months since. This article in this country is almost entirely made from foreign stock, and that we should propose to use is the very best ever brought to this country.

"The wood for poles would vary in different localities, cypress, pine, cedar, and chestnut all being used. In many cases the average requirement has been the basis of estimate, and transportation has been included as an element of cost. The instruments required for testing lines, magnets, qualities of wire, resistances, and batteries have also been introduced, as their use has become an essential in working lines and preserving their efficiency.

"Very respectfully, your obedient servant,

"CHARLES T. CHESTER.

"The POSTMASTER-GENERAL OF THE UNITED STATES.

"P. S.—This estimate covers the best possible construction, with all modern improvements, connecting 10,000 offices. As good a line as now constructed in this country can be put up for about 25 per cent. below this statement.

"175,000 miles No. 8 galvanized Chester A 1 wire, duty free, 8¾ cents per pound, 400 pounds to mile..........	$6,125,000
"75,000 miles poles, 33 to mile, average $2 each.........	4,950,000
"Setting 75,000 miles of poles, at $1 each...............	2,475,000
"Stringing 175,000 miles of wire, at $5 per mile.........	875,000
"5,775,000 insulators, screw-glass, with brackets, 12 cents.	693,000
"5,775,000 Brooks insulators, at 35 cents.	2,021,250

“1,650,000 cross-arms, average at 25 cents each..........	$412,500
“1,000,000 feet of office-wire, 750,000 braider, at 1¼ cents.	9,375
250,000 kerite, at 5 cents...	12,500
“9,500 cut-outs, at $1	9,500
“9,500 lightning-arresters, at $2..........................	19,000
“500 switch-boards, average $35 each	17,500
“13,000 Morse relays, average resistance, $15 each.......	195,000
“12,000 best sounders, $6 each..........................	72,000
“2,000 registers, best pattern, $40 each..................	80,000
“14,000 best keys, $5.20 each	77,000
“28,000 best sulphate of copper batteries, at $1.25 each..	35,000
“1,000 Chester dial instruments, at $75..................	75,000
“500 ordinary galvanometers, at $10 each...	5,000
“50,000 best electropoin or carbon batteries.............	87,500
“50 complete testing-instruments, rheostats, and galvanometers	7,500”

This estimate being added up with the items for Brooks insulators, which are very little used, and cross-arms being stricken out, (the estimate being only required to cover one mode of construction,) the total is found to be a little less than $16,000,000. Mr. Chester's estimate provides for ten thousand miles of wire and for connecting four thousand more offices than were then in existence at the time it was made. He states in a postscript that it “covers the best possible construction, with all modern improvements. * * * As good a line as *now constructed* in this country can be put up for about 25 per cent. below this estimate.” That reduces the estimate to a little below the figures of the Postmaster-General's table. Notwithstanding that, Mr. Chester says that “wire, the most expensive element of construction, is at present, owing to the enormous increase in value of coal and labor in England, more than 30 per cent. higher than it was six months since.”

Published statements like the foregoing should be sufficient to set at rest all question of the cost of erecting and equipping telegraphs in this country.

69. With regard to the traffic in the United States, the information at hand is not so full. In default of statistics from disinterested sources, the figures furnished by the Western Union Telegraph Company in 1872, in a letter to the Postmaster-General, are adopted as the basis of calculation. These figures are: for the year ending June 30, 1872, 10,271,935 paid messages, 660,203 partially paid and free messages, 1,512,361 press messages.

In the annual report of the president of that company for 1869 he assured the stockholders that their lines, however profitable, carried messages at less rates than the government telegraphs of Europe. So far back as 1867 the number of messages, according to this report, “excluding many millions on railroad business,” was 10,067,768; the gross receipts, $5,738,627.96, and the average cost per message, 57

cents. But in 1872, when it was desired to secure for the company an increase in the rates on signal-service messages, the following "statistics" were presented to the Committee on Appropriations of the House of Representatives:

Year.	No. of messages, (paid and free.)	Receipts.
1868	6,373,095	$7,264,852 74
1869	7,198,854	7,271,918 96
1870	7,859,028	7,323,430 75

The statistics for 1872, being the latest, must be accepted.

The other portions of table No. 1 will explain themselves, or will be explained by the full notes appended to it.

70. With regard to Table No. 2, it will be noticed that the heavy increase of traffic following immediately upon a large reduction of tariff has not required a great addition to the number of offices. Neither has it demanded extraordinary expenses in the erection of lines or increase of operating force. The net profits have always, however, been diminished. Had European governments such a margin of profits to draw upon as the company, for instance, whose lavish expenditure of $147,000 noted above (which was re-imbursed threefold from the public treasury) has swelled into a capital of $6,000,000, earning 7 per cent. annually, they could make reductions without fear. To these instances of the considerable increase of business consequent on a reduction of tariff may be added the case of Canada, or rather of the Montreal Telegraph Company, whose reduction of a tariff applicable to only 10 per cent. of the business increased the number of messages 25 per cent. in the first year. In England the increase of the number of messages from three or four millions under the *régime* of the companies to seventeen millions under that of the government is doubtless due as greatly to the multiplication of facilities and energetic management introduced by the latter as to the reduction in tariff. There also, as well as in Canada, much was due to the simplification of the tariff.

Table 3, if it could be compared with similar data for the United States, would doubtless illustrate more forcibly than anything else the superiority of the European telegraphs to our own. That in Belgium, with her limited territory, her perfect postal system, and her frequent rail communications, the telegraph is used for social and private affairs to the extent of 60 per cent. of the total traffic, is the strongest possible argument in favor of the system of which this little state is perhaps the best exponent.

71. CONCLUSION.—Much more might be said upon the topics on which I have touched thus lightly, and there are numerous others connected with the general subject of telegraphs which might be enlarged upon to advantage. There is no lack of writers, however, better able than myself to undertake the task, and I leave it to them. The subject, although comparatively new and attractively clear and simple in its outlines, is yet much too vast for the dimensions of a report like this.

73. TABLE No. 2.—*Table showing the correspondence by telegraph before and after the reductions of tariff in the following countries.*

Year.	No. of offices.	No. of internal messages.	Receipts.
BELGIUM.			
Internal tariff, 1 franc for twenty words.			*Francs.*
1860	141	80, 216	142, 344. 91
1861	163	97, 945	171, 225. 78
1862	196	105, 274	176, 643. 25
1863	241	188, 825	211, 063. 63
1864	279	252, 301	282, 591. 68
1865	307	332, 721	345, 289. 42
December 1, 1865.—*Internal tariff,* 50 *centimes for twenty-five words.*			
1866	356	692, 936	407, 932. 00
1867	374	817, 652	469, 749. 60
1868	410	972, 038	549, 263. 20
1869	433	1, 108, 737	598, 739. 70
1870	445	1, 343, 118	744, 641. 00
1871	478	1, 560, 673	856, 583. 00
1872	522	1, 589, 344	867, 448. 25
SWITZERLAND.			
Internal tariff, 1 *franc for twenty words.*			
1860	145	208, 311	224, 484. 35
1861	157	217, 700	233, 631. 50
1862	177	241, 814	259, 308. 45
1863	200	298, 778	318, 495. 70
1864	224	325, 165	344, 829. 90
1865	253	364, 118	381, 378. 13
1866	285	383, 159	400, 152. 80
1867	333	397, 333	412, 019. 77
January 1, 1868.—*Internal tariff,* 50 *centimes for twenty words.*			
1868	394	798, 186	446, 235. 59
1869	459	951, 337	520, 198. 03
1870	546	1, 132, 029	674, 697. 27
1871	623	1, 309, 214	775, 197. 63
1872	707	1, 480, 757	....
AUSTRIA-HUNGARY.			
November 1, 1858.—*Internal tariff,* 1.50 *francs for the first zone,* (10 *geographical miles,*) *with an increase of the same amount for each additional* 5 *miles.*			
1860	516	491, 119	1, 478, 187. 50
October 1, 1863.—*Internal tariff,* 1 *franc for the first zone;* 2 *francs for* 10 *to* 45 *miles;* 3 *francs for* 45 *to* 100 *miles.*			
1865	874	1, 361, 345	3, 683, 917. 50
April 1, 1870.—*Internal tariff,* 1 *franc for the first zone and* 1.50 *francs beyond.*			
1870	1, 697	3, 149, 148	4, 697, 975. 00
1871	2, 276	4, 130, 216	5, 384, 730. 00
GERMANY.			
January 1, 1859.—*Internal tariff of* 1.25 *francs for each zone,* (10 *geographical miles.*)			
1860	518	239, 653	804, 285. 00
January 1, 1861.—*Internal tariff of* 1.25 *francs for each zone,* (1 *zone,* 10 *miles;* 2 *zones,* 10 *to* 25 *miles;* 3 *zones,* 25 *miles and beyond.*)			
1861	624	289, 794	915, 885. 00
January 1, 1862.—*Internal tariff of* 1 *franc for the first zone,* 10 *miles;* 2 *francs from* 10 *to* 25 *miles, and* 3 *francs beyond.*			
1862	741	462, 770	968, 947. 00
October 1, 1863.—*Internal tariff of* 1 *franc for the first zone;* 1.25 *francs from* 10 *to* 45 *miles, and* 2 *francs for beyond.*			
1863	904	636, 773	1, 175, 482. 00
1864	1, 012	395, 322	1, 327, 114. 00
1865	1, 139	1, 071, 809	1, 510, 690. 00
1866	1, 229	1, 297, 294	1, 830, 109. 00

A	, 892	
P	, 691	3,
M	, 828	
M	, 961	
N	252	
C	, 676	
N	148	
N	582	
In	, 695	h2
In	, 657	
T	, 352	2
In	, 659	
T	, 330	
T	646	
T	341	2
Fr	052	
Fr	135	
T	187	
D	657	
T	844	
Sa	203	13
M	757	2
T	960	16
	884	......
	....	9
Sq		1
Sq	4	1
Sq		29
In		33, 29
M	8	1
C	20	12
C	05	3
M		8
M		1, 54
In		1
R	343	
R	331	
R	362	
A	07	21
E	306	
E	......	...
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71. Figure
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TABLE No. 2.—*Table showing the correspondence by telegraph, &c.*—Continued.

Year.	No. of offices.	No. of internal messages.	Receipts.
			Francs.
July 1, 1867.—*Internal tariff of* 60 *centimes for the first zone;* 1.25 *francs for the second zone,* (45 *to* 52 *miles,*) *and* 1.90 *francs beyond.*			
1867	1, 794	2, 293, 020	2, 645, 284. 00
1868	2, 051	3, 668, 930	3, 446, 190. 00
1869	2, 208	3, 934, 184	3, 960, 921. 00
1870	2, 405	433, 902	4, 468, 361. 00
1871	2, 615	4, 907, 663	4, 838, 108. 00
1872	3, 058	6, 911, 375	6, 521, 865. 00
ITALY.			
January 28, 1860.—*Internal tariff of* 1.20 *francs for twenty words in a range of* 100 *kilometers, and of* 2.40 *francs beyond.*			
1868	963	1, 306, 435	2, 639, 549. 52
1869	1, 032	1, 450, 797	2, 786, 735. 13
1870	1, 063	1, 549, 724	2, 866, 040. 72
July 1, 1871.—*Internal tariff of* 1 *franc for fifteen words.*			
1871*	1, 202	2, 124, 355	3, 198, 061 75
FRANCE.			
May 18, 1858.—*Internal tariff of* 2 *francs, fixed, and* 10 *centimes per myriameter for twenty words;* 1 *franc in the same department, and* 1.50 *francs between adjacent departments.*			
1860	989	568, 365	2, 358, 525. 21
1861	1, 117	734, 352	2, 840, 445. 84
January 1, 1862.—*Internal tariff of* 2 *francs for twenty words, and* 1 *franc for the same department.*			
1862	1, 271	1, 291, 774	2, 954, 490, 21
1863	1, 380	1, 490, 023	3, 305, 993. 85
1864	1, 498	1, 654, 406	3, 565, 933. 68
1865	1, 926	2, 098, 645	4, 159, 445. 45
1866	2, 310	2, 379, 681	4, 513, 095. 32
1867	2, 573	2, 682, 810	4, 969, 618. 65
Law of July 4, 1868.—*From the* 4th *of July reduction of* 50 *centimes in the tariff within the same department.*			
1868	2, 829	2, 916, 734	....
Law of July 4, 1860.—*From November* 1, 1869, *reduction of* 1 *franc for all dispatches, except in the same department.*			
1869	3, 142	4, 085, 408	5, 636, 289. 92
1870	3, 231	4, 042, 302	5, 193, 168. 80
1871	3, 271	4, 371, 952	4, 494, 023. 55
April 6, 1872.—*Internal tariff of* 60 *centimes for the same department, and* 1.40 *francs for the rest of France.*			
1872	3, 463	5, 735, 590	6, 941, 526. 62

* This increase accrued almost entirely in the second half of the year.

74. TABLE No. 3.—*Classification of dispatches according to their nature.*

	Internal.				International.				Total percentage.			
	1869.	1870.	1871.	1872.	1869.	1870.	1871.	1872.	1869.	1870.	1871.	1872.
BELGIUM.												
Official dispatches	0.50	0.75	0.50	0.26	0.75	0.75	0.50	0.58	0.50	0.75	0.50	......
Stock-reports	5.	3.50	4.	4.66	12.50	10.50	9.50	10.52	8.75	7.	6.75	......
Commercial affairs	34.	37.75	36.	38.47	56.25	55.25	48.	53.78	45.	46.50	42.	......
Private and social affairs	59.50	56.	58.	55.35	28.25	30.75	40.	33.31	44.	43.25	49.	......
Press-dispatches	1.	2.	1.50	1.26	2.25	2.75	2.	1.81	1.75	2.50	1.75	......
SWITZERLAND.												
Official dispatches	......	......	0.74	1.12	......	......	0.22	0.51	......	......	0.48	0.82
Stock-reports	......	14.70	2.88	4.50	......	20.02	8.89	7.87	......	17.36	5.88	6.19
Commercial affairs	......	35.34	34.16	31.80	......	43.04	50.	45.58	......	39.19	42.08	38.68
Private and social affairs	......	47.06	60.60	60.98	......	36.09	40.30	44.94	......	41.98	50.45	52.96
Press-dispatches	......	2.90	1.62	1.60	......	0.85	0.59	1.10	......	1.82	1.11	1.35
ITALY.												
Political news	12.61	5.67	5.87	......	17.23	7.98	7.83	......	......	......	......	......
Commercial affairs	41.90	44.92	48.08	......	56.44	56.91	60.35	......	......	......	......	......
Divers affairs	45.37	49.32	45.96	......	26.06	34.74	31.77	......	......	......	......	......
Cipher-messages	0.12	0.09	0.09	......	0.27	0.37	0.05	......	......	......	......	......

FRANCE—1859.

[This division has only been made in France in the years 1859 and 1860.]

	Internal.	International.
Official dispatches	....	5.13
Private and social affairs	35.88	21.76
Press-dispatches	2.77	9.65
Grain-trade	5.50	4.83
General commerce and industry	44.27	35.07
Affairs of the bourse	10.85	23.23
Unclassified	0.73	0.33

AUSTRIA-HUNGARY.

[City of Vienna, 1871.]

	Sent.		Received.	
	No. of messages.	Per cent.	No. of messages.	Per cent.
Affairs of the bourse	280,516	33.9	159,963	20.9
Commercial affairs	248,867	30.1	186,720	24.4
Press-dispatches	36,164	4.3	26,783	3.5
Private and social affairs	111,628	13.5	210,479	27.6
Divers affairs	147,989	18.2	181,269	23.6

INDEX.

ADDENDA.

Duplex Telegraphs.—A duplex instrument, as simple and as effective as that of Stearns, has been devised by the well-known electrician, Mr. C. H. Haskins, of Milwaukee, and adopted by the Northwestern Telegraph Company. Unfortunately, the description of this instrument was received too late to permit engraving the plates, and it must be omitted. Mr. Haskins has also discovered that condensers may be used as translators or repeaters, a discovery, the importance of which can hardly be overestimated.

*Quadruplex Telegraph.**—The quadruplex is based upon the "bridge" duplex, a device of Mr. Stearns, in which a relay is placed in the bridge-wire of a Wheatstone balance, so as to be affected only by currents from one end of the line. In the quadruplex, two relays are so placed, the one having little resistance, and responding only to strong currents, and the other, a polarized relay, being sensitive to feeble ones. The passage of a current of one polarity repels the armature of the latter relay, and a current of the opposite polarity attracts it. The battery at either end is divided into unequal parts, the smaller of which is too weak to affect the ordinary relays. A "double-transmitter," or pole-changer at each end, operated by a local magnet, controlled by a key in the local circuit, allows the weaker portion of the battery to remain in the main circuit with a polarity opposed to that of the sensitive relay; or, when the key is closed, brings the same portion into circuit with the same polarity as the sensitive relay, and closes it. A "single-transmitter" brings the larger portion of the battery into circuit, its polarity following that of the smaller portion for the time being. Neither transmitter affects the receiving-instruments at its own station, as the current divides on the arms of the balance, between the line and the rheostat. If the weaker battery at either end be brought into circuit with the proper polarity, it closes the sensitive relay at the other end, but does not affect the ordinary relay. If the rest of the battery be added, the effect on the sensitive relay is merely strengthened, and the ordinary relay also responds. If the larger portion of the battery only be brought into circuit, its polarity is the reverse of that of the sensitive relay, and the ordinary relay only responds. A condenser is placed in the bridge-wire to render the action of the relays as steady as possible under the constant reversal of polarity and variations of battery-power to which this arrangement is subjected; but even with this aid, its working requires the closest attention and the nicest adjustment.

* This account should have been given in the body of the report, page 34, but was received too late for insertion.

Gray's Simultaneous Method.—By far the most wonderful advance in simultaneous telegraphy that has yet been made—an advance resting upon a discovery as important, scientifically or practically considered, as that of Ampère or of Oersted—is the work of Mr. Elisha Gray, of Chicago. Mr. Gray, by a curious accident, discovered that, by taking one pole of the secondary of a Rhumkorff induction-coil in his hand, and rubbing with the fingers of the other hand a resonant piece of dry metal, to which the other end of the coil was connected, he produced a sound similar in pitch and quality to that given out by the electro-tome or vibrator of the coil. From this small beginning he arrived, by patient investigation, at the most astonishing results. He constructed a key-board, with a range of one octave, each key of which brought into circuit a battery actuating electro-magnets, two for each key, between which vibrated electro-tomes, tuned to eight different pitches. These vibrations transmitted electrical impulses over a wire, in the circuit of which was placed an ordinary magnet mounted on a sounding-board. On depressing any key, the note of its vibrator was immediately sounded on the magnet at the other end of the wire. When two or more keys were depressed, the magnet gave forth their combined musical tones. By placing eight magnets in the main circuit, instead of one, each having a fixed armature, tuned to the same pitch as one of the transmitting-vibrators, it was found that each armature would respond only to the vibrations of its corresponding transmitter. By employing such armature to close an auxiliary circuit, an "analyzer" was produced, by means of which the depression of each key was recorded at the other end of the wire on a separate magnet. A multiple telegraph was thus formed, adapted to any system, and increasing its capacity to a point only limited by the number of separate musical tones which could be produced. This discovery, whether applied to the Morse, the printing, or the *fac-simile* system, is doubtless destined to supersede all other multiple telegraphs, and its importance in the future extension of telegraphic communication can scarcely be imagined. The plates illustrating this sketch were promised by the inventor, but were not received in time for use. The simplicity of the system is such, however, that its principle will be readily understood.

Fac-simile Instruments.—A *fac-simile* instrument has been devised by Mr. W. E. Sawyer, of Washington, similar in its general features to that of d'Arlincourt, but containing an improvement in preparing the message for transmission. The message is written on ordinary paper and an impression taken on a zinc plate. A powdered substance is sprinkled on the surface of the plate, which is heated, and adheres to the lines of the writing, forming a ridge, which gives a perfect mechanical insulation. The surface of the zinc plate is a much better conductor than that of a metallic paper.

Mr. Sawyer also claims a much greater speed for his instrument than that attained by the European systems.

J.

TELEGRAPHS AND APPARATUS.

DAVID BROOKS.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

TELEGRAPHS AND APPARATUS.

BY

DAVID BROOKS,
HONORARY COMMISSIONER OF THE UNITED STATES.

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CHAPTER I.

INSTRUMENTS AND SYSTEMS.

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1. RELAYS.—The original relay of Professor Morse was wound with No. 14 copper wire, covered with cotton, and weighed one hundred and eighty pounds. The magnetic effect of this construction, owing to the comparatively few convolutions obtainable with such coarse wire, was very feeble. The French, however, shortly effected a considerable improvement in the construction of the relay by employing a smaller core and winding the same with a fine wire covered with silk. The cores of most of the instruments used in Europe at the present time are about four inches in length and of less than three-eighths of an inch in diameter, and are wound with a fine silk-covered wire, affording a sufficient number of layers or convolutions to give to the spool a diameter of one and one-eighth inches. The spools of the relay are longer, and smaller in diameter, than is the case with the form of this instrument generally in use in the United States.

The advantages derived from the use of cores of such construction may be briefly stated to be as follows:

First. Greater attractive force as a magnet is obtained.

Second. A greater number of convolutions are obtained in proximity to the core.

Third. The winding of the spool, not being attended by any considerable increment to its diameter or thickness, the outer convolutions add less resistance; and as a necessary consequence of the second specification, being nearer to the core, they give greater magnetic effect.

Fourth. Such relays have much lighter armatures than the American.

Fifth. As the result of this difference in construction, the relay is worked by a much less battery-power.

2. It is probable that the firm of Siemens Bros., London, and of Siemens & Halske, Berlin, make by far the greater number of the relays in use in Europe. It has for years been the custom of these makers to mark on the end of the spool of each of their instruments, the resistance of the spool in Siemens units, as also the number of convolutions of silk-covered wire which each contains. The number of convolutions being the measure of the magnetic effect, the intelligent telegrapher is thus

readily enabled to select the relay that is best adapted to the circuit in which it is to be used. For short lines, or for lines having many relays in circuit, instruments with coarser wire and fewer convolutions are the best adapted; for long circuits the finer-wire relays are more suitable.

It is the prevailing opinion among instrument-makers, and many others in the United States, that relays with cores of considerable length do not charge and discharge as rapidly as smaller ones, an opinion which is probably well based. In the sense that a large core is not charged or discharged as soon as a small one, it is true; but the instrument of the size and length to which reference has been made, can be charged and discharged automatically with such rapidity as to produce the Morse characters and writing at a rate of speed fully three times as great as that attainable by the most expert operator—a fact which offers a sufficient answer to the objection above expressed; while the form of the relay is a marked improvement over the relays in use in this country.

3. SIEMENS' POLARIZED RELAY.—This form of the instrument is an improvement over the ordinary form in working long circuits, inasmuch as it is more sensitive and requires less battery-power. It is operated automatically on the line from London to Teheran, a distance of three thousand eight hundred miles, at a speed asserted to be as much as twice that of the ordinary Morse. In this circuit there are three and sometimes five repeaters. The writer observed that relays of this construction were in use on the longer circuits in all the countries of continental Europe which he had the opportunity of visiting, and the opinion there is universal that they are superior to the ordinary relay. It is worthy of remark that no instruments of this construction are in use in the United States.

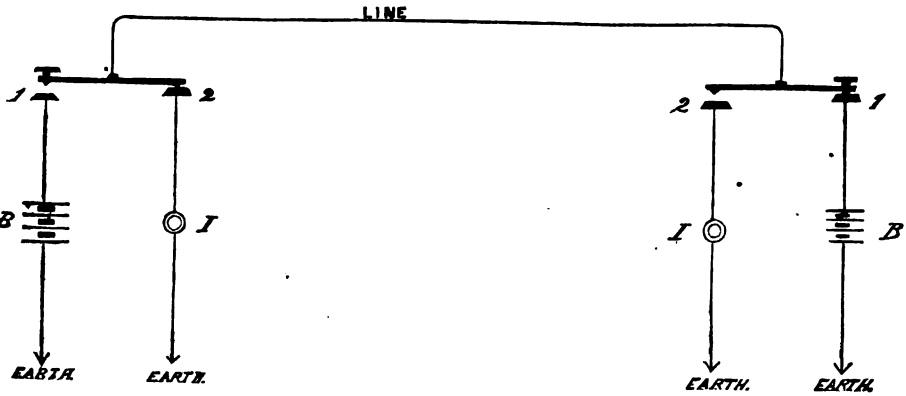
4. METHOD OF CONNECTING UP THE MORSE CIRCUIT.—The original method of connecting up the circuit, which was adopted by Professor Morse, and never changed or modified in the United States, was from ground to battery, battery to key, key to relay, relay to line, line to relay, relay to key, key to battery, and battery to ground. These connections form a line of two stations, one at each terminal. The intermediate stations were formed by placing a key and relay in the line. The Germans soon improved upon this method by employing keys made with two insulated anvils, and making the connection thus. Fig. 1, page 7, will suffice to explain the operation of this system.

When the keys are open, they rest upon the back anvil, 2; closing a key sends a current to line and key of the other station, which rests upon the back anvil and sends a current to instrument I. Should one station wish to stop or "break" the other, it is only necessary for the operator to close his key and send a current into the instrument of the other station. The advantages of this method of connection are obviously as follows:

First. The relay is not affected by escape, and requires less adjusting

Second. Operators, while sending messages on a line affected by escape, are frequently governed by the slow response of their instruments to the manipulations of their respective keys, and are apt to imagine that, because their own local does not respond quickly, the instrument at the other terminal is similarly affected in its working. Laboring under this impression, they make dots of too great a length, and their characters at the receiving-station are not sufficiently spaced, and in other respects are badly formed. Lines affected by an escape are much more easily operated with this than with the American method, while on lines not affected by an escape this system has no advantages; moreover, it necessitates the presence of a battery at each sending-station.

FIG. 1.



5. THE MORSE REGISTER.—The original Morse register is now entirely superseded in Europe by the ink-writer. The original apparatus has long been felt to be defective in the following particulars:

First. It required a considerable weight to move the train.

Second. Inequalities in the thickness of the paper, or other causes, are apt to occasion the paper to stop between the rollers, thus producing imperfect characters or omitting them altogether.

Third. The characters of the Morse are only legible when held between the person and the light, or in such a position as to bring a shadow of the impression in view to the eye.

Fourth. The character is very easily erased or obliterated, and, hence, poorly adapted for preservation as a record or proof of correct or incorrect transmission.

6. The defects here enumerated as inherent in the Morse register are completely obviated in the ink-writer as manufactured by Siemens Bros., Digney, and others. The train is moved by a spring of slight tension; the speed of the instrument is uniform, and its operations noiseless; the paper ribbon is but about one-third the width of that used in the embossing-apparatus, and the material itself of lighter body, in consequence of which a roll occupies a comparatively small space, usually

in a drawer beneath the instrument; the characters being in ink are consequently as legible to the operator as printed matter; the strip is preserved to serve as evidence to determine disputed questions concerning correct transmission or reading, and an error is thus easily traced to the operator committing it, and not permitted to rest between two, one of whom is innocent. The cost of this instrument is about double that of the original Morse.

The defects of the American Morse register led to its gradual disuse, and the adoption of the sounder. The register made sufficient tick to be audible, and the operator while using the register soon became so familiar with the ticking as to be able to read the dispatches by ear. Within two or three years after the telegraph was fairly in operation in this country, there were operators who read entirely by sound, but the sound was that of the ordinary register. It was not until some years afterward—about the year 1858—that sounders were made, instruments constructed upon the same principle as the register, with the clock-work and paper omitted. The advantage afforded by the ability to read by sound resides in the fact that the operator is not obliged to direct his eye from his pen while copying the dispatches, a case precisely analogous to that of a person taking a copy with the words read or spoken to him, instead of being obliged to read them for himself.

If the operator is a rapid penman he can even direct his eye from his pen at times and keep pace with the writing of the characters as they are made by the transmitting-operator at the other terminal. This is the more easily done where the characters are in ink, as made by the Morse ink-writer. In Europe, indeed, operators frequently read by sound, but the copy, as printed by the ink-writer, is preserved for reasons before stated. As the magnetic force required to work the pen of the ink-writer is small compared with that required to emboss, it permits of the ink-writer being worked in the direct circuit of the line, and to that end the core of the magnet is wound with fine wire, giving the helices a resistance of five hundred units, or less, according to the length and resistance of the line. This arrangement dispenses with the local battery.

The chief and obvious advantage of the ink-writer over the American sounder consists in the ease of learning to read the printed characters, as compared with the difficulty of learning to read by sound. The printed characters are legible to a beginner as soon as the alphabet is known, a task which a person of average intelligence may accomplish in a day; while to learn to read by the sounder necessitates a familiarity with the tick which cannot be acquired save by the practice of a year. Good sound-operators are expensive; that is they command salaries twice as high as operators who read the printed characters equally well and are otherwise equally qualified.

Another objection may with good cause be urged against the sounder, as employed in this country. It is usually placed in public places, such

as hotels, commercial exchanges, railroad-stations, and the like, where the click can best be heard by the public and attract attention. This public situation places it within the power of evil-disposed persons to make improper use of information which they may readily acquire. Operators, for example, who are out of employ, or who are in the employ of rival companies, or who have left the service, can, without difficulty, from the sound of the instrument, read the contents of dispatches and make use of such information to serve their own purposes. There is every reason to believe that this is often systematically practiced. The substitution of ink-writers for the sounders would obviously overcome this grave objection.

7. THE HUGHES PRINTER.—This apparatus is an American invention, and was first brought out in the United States some fifteen years ago. Subsequently the inventor took up his residence in Paris, where, with the assistance of the Digney Frères, his instrument was much improved. They are now manufactured by this celebrated Paris firm, as well as by Siemens Brothers, of London, and Siemens & Halske, of Berlin.

The clock-work of the instrument is driven by a weight, which is wound with the aid of a treadle; in order that the train shall be kept in motion, it is simply necessary that the operator should press the treadle with the foot as often as once in two or three minutes. For the transmission of business between large cities, or commercial centers, requiring the exclusive use of one or more wires, this instrument has great advantages, to wit:

First. The speed of transmission is fully, or even more than, double that of the Morse system, a statement based upon the experience of the telegraph-chiefs at Berlin, Brussels, Vienna, Berne, and Paris. The efficiency of the instrument is therefore vastly greater than that of the Morse, since two operators with one wire can perform as much service, or more, than four operators with two wires worked by the Morse system.

Second. There is less liability of the occurrence of errors in transmitting dispatches, since they can only arise from an incorrect reading of the manuscript of the original, while, with the Morse system, by far the greater number of errors arise from incorrectly interpreting the Morse characters, whether by the sounder or the register; and

Third. The dispatches are delivered in plain Roman characters.

As an indication that its merits are duly appreciated, it is only necessary to state that by far the larger portion of the telegraphic business of Germany, Belgium, France, and Switzerland is performed by this instrument.

BELGIAN TELEGRAPHS.

8. BATTERIES.—The batteries employed in Belgium are the Marie-Davy, the Leclanché, (a modified Bunsen,) and the Minotto. This last is the Callaud, with a layer of sand about four inches in depth resting upon the sulphate of copper; the zinc plate rests upon the sand. Of

these several elements, the Leclanché is preferred on account of its economy, for which and other reasons it is believed this form will ultimately supersede all others.

From five to six lines are worked from one battery or set of elements. The wires worked from one battery are those having, as nearly as possible, equal resistances.

9. INSTRUMENTS.—The instruments employed are the Hughes printer and the Morse ink-writer. In the Brussels office there are in use eighty Morse, and fifteen Hughes instruments. The cost of the Hughes instrument is about 1,700 francs; that of the Morse 600 francs. The capacity of the Hughes is stated to be fully double that of the Morse.

10. POSTS.—The kinds of timber employed for posts are the pine, the fir, and the larch. The latter is the most durable, but is expensive. The posts are all injected with sulphate of copper, as a preservative material, by the Boucherie process, which is claimed to afford excellent results. Posts treated by this process, and set in 1850, are still in good condition.

The posts are planted ninety meters distant from each other, and average, therefore, about eighteen to the mile. The same number of posts are employed for a line of one or two wires as for a greater number, though in the latter case higher poles are used. Usually, a set of poles carries from eight to twelve wires. All the poles stationed upon angles or curves are guyed or braced. Those standing in the straight line have a slack guy attached to the post and fastened in the ground, on the side opposite to the track of the railway, in order that in case of accident the poles may not fall across the track and endanger the trains.

11. INSULATORS.—The insulators employed are of porcelain, attached to the post by means of an iron strap, which encircles the insulator, the strap in turn being fastened securely to the post by screw-bolts. There are two sizes of this insulator in use. One of large dimensions for the heavy wire, and the other of smaller size for the lighter wires. The wire is suspended in an iron hook. In the larger insulator, this hook is covered with hard rubber; with both sizes, the strap, screw-bolts, and hook are galvanized. The cost of the large insulator is two francs and seventeen centimes each, that of the smaller size sixty-five centimes.

12. WIRE CONDUCTORS.—There are three sizes of wire employed. For the shorter circuits, which embrace all those not extending beyond the limits of the kingdom, a wire of three millimeters diameter is in use. This wire will weigh about two hundred pounds per English mile, and corresponds very nearly in size to our No. 11. The four-millimeter wire corresponds in size to our No. 8, and is employed for the circuits extending beyond the kingdom. An exception must, however, be made in the case of the longest of these extra Belgian circuits, such as those leading to Paris and Berlin, and designated by the term "international," upon which a wire of five millimeters is used. This

international wire will weigh about five hundred and fifty pounds to the (English) mile, and corresponds very nearly to our No. 6. This wire is manufactured in Belgium, and its quality is most excellent.

13. UNDERGROUND LINES.—In the streets of the large cities, Brussels and Antwerp, no posts are to be seen. Usually seven copper conductors, insulated by gutta-percha and protected by an outer shield of iron wire, are employed. These seven conductors, with their insulated coverings and iron shields, constitute a cable. Two or more of the cables are laid in a brick trough, and the space about them filled out with sand. The wires laid in this manner have remained in perfect preservation, and the plan has proven itself to be eminently practical, involving neither trouble nor expense on the score of deterioration. Any one who is in the least familiar with American telegraphs, cannot fail to be most favorably impressed with the greater strength and permanence manifest in the construction of the Belgian lines, and with the evidences of the skill employed and expense incurred to make them reliable and serviceable. As an indication of the great extent to which the telegraph is used, it will suffice to mention that in the city of Antwerp there were sent and received during the month of April last no less than 44,752 dispatches, representing an amount of business which in this country would be considered very large for any city of twice its size.

The comparison becomes more instructive when it is remembered that the kingdom of Belgium occupies but a small territory, and that by far the greater number of the dispatches are sent for distances so short as to be readily attainable by the mail in a few hours. There is, consequently, less saving of time—that is, less necessity for employing the telegraph as a means of communication—than in a country like ours, where persons are necessitated to hold communication with each other over spaces far more widely separated.

14. AUTOMATIC TELEGRAPH.—During the past six years much attention and inventive skill have been directed, both in Europe and in the United States, to the improvement of processes for telegraphic transmission, the object of these endeavors being to do automatically what has hitherto been done by hand. In all, or nearly all, of these improved processes, perforated paper is substituted as a means of transmission, in place of a Morse key. By any of these improved methods the transmitting capacity of the line is augmented at least threefold, in the same length of time, over that of the ordinary Morse, though it is but fair to state that their employment affords no economy in the number of operators required, the gain in this particular residing in the employment of a lesser number of wires. The same number of words may be transmitted upon one wire as may ordinarily be sent upon three; but to do the work automatically requires the same number of employés upon one wire as upon three wires employing the Morse key.

15. Siemens Brothers exhibited at Vienna their automatic system, consisting of a perforator, a transmitter, and a recorder. In the work of

transmission there are employed two batteries with alternating currents, adapted to the use of their polarized relay. In working at a rapid rate, very sensitive and quick-working recording-instruments are necessary, a requirement which these polarized relays and recorders are especially adapted to meet. The method of alternating currents is a device for either obviating or reducing difficulties due to induction, which always manifest themselves where the attempt is made to operate lines of great length at high speed. The system of Siemens Brothers appears to meet entirely, or at least to a great degree, all the requirements of practice.

16. A noticeable feature in the Prussian department is the system or invention of Gustav Jaite, of Berlin. Connected with all these methods of automatic transmission is the perforator, upon the design of which much skill and ingenuity have been bestowed. The perforator of Jaite is compact in form and portable, and can be operated at great speed, the strips of paper being moved by clock-work. The holes are punched by electro-magnets operated by two keys. By pressing one key, dots will be made so long as it is held down; while by pressing both keys, dashes will be made so long as the pressure is continued. As the paper strip is moved along at a fixed rate of speed, these dots and dashes will appear at regular intervals. It is by pressing these keys in conjunction, or the dot-making key separately, that the letters or characters are formed. This machine appears to possess great advantages, and in practiced hands will doubtless execute a large amount of work.

17. The system of Wheatstone is used to a considerable extent in England in the transmission of dispatches for the press. A paper once perforated answers the purpose of transmitting the same dispatch in any direction. The perforations are made in the London station by means of compressed air. It is really surprising to observe the skill displayed and the speed attained by the operators working these machines.

None of the European automatic processes, however, approach in speed of transmission that of the American system of Little, the record or characters of which are made by the current itself, on chemically prepared paper.

Of the relative advantages or disadvantages of the several processes here enumerated, it would be difficult to venture any opinion, further than that it would be both wise and economical to adopt any of them, rather than to increase the number of wires that already exist between large commercial centers.

18. DOUBLE TRANSMISSION is practiced to a considerable extent in the United States, and to a less extent in England. Theoretically considered, the doubling of the number of operators should also double the amount of work to be obtained upon a wire, as compared with its operation by the ordinary method of transmission; but this result is seldom attained in practice. But even under the supposition that the theoretical limits of

this method of transmission were attained in the practice of the United States, or of England, the performance would no more than equal that reached on the Continent upon one wire by the employment of the Hughes instrument with half the number of operators.

These comments, however, must not be interpreted as applying to the system of double transmission in general, inasmuch as it can be introduced to augment or multiply the transmitting capacity of the Hughes, as well as that of the Morse.

CHAPTER II.

CONSTRUCTION OF LINES AND ADMINISTRATION.

WIRE CONDUCTORS IN EUROPE; BATTERIES; MEASURES OF RESISTANCE; MORSE'S ALPHABET; PRESERVATION OF TIMBER; LINE-CONSTRUCTION; INSULATORS; UNDERGROUND-WIRES; PNEUMATIC TUBES; MONOPOLY OF THE TELEGRAPH; COST OF LINES; BRANCH-LINES; RATES; SYSTEM DESIRABLE.

19. WIRE CONDUCTORS.—The wires employed in Europe for the long circuits, called the "international circuits," and working generally direc from capital to capital, forming thus the transcontinental lines, are of five millimeters diameter. The material of this wire would weigh about five hundred and forty pounds per English mile. On the main routes of travel, more than half of all the wires seen are of this larger size. By agreement between the nationalities, effected some years since, this size of wire was adopted as the "international." For the less important circuits, wire of four millimeters diameter is employed, the weight of which per mile is about three hundred and twenty pounds, a size corresponding very nearly to the American No. 9.

For the branch-lines, that is for the lines leading from the main routes to the towns and villages not situated in the path of railways, there is employed in France, Belgium, and Switzerland a wire of three millimeters. Its weight is about two hundred pounds per English mile. In Germany, there is employed for similar purposes a wire of two and a half millimeters diameter, weighing about one hundred and forty pounds. This smaller size is also used for running in wires to stations, for crossings of the railway-track, &c., uses for which it is specially adapted, being so light that it can be pulled very taut, and the slack taken up without material strain upon the posts. If caught by passing trains the consequences are not so serious as when wires of greater strength are employed.

An erroneous opinion is prevalent among telegraph people in our country that a small wire cannot be used for such purposes without materially diminishing the conductivity of the circuit. It does so, however, only in proportion as it reduces the weight of the wire of that circuit, which forms a portion of the resistance. In a line, for example, of two hundred miles, if all the crossings and running-in wires were of No. 13 wire, the loss in conductivity on that account would be so small as to be practically inappreciable. The smaller wire, again, is more easily spliced and manipulated.

The English practice is to use upon the longer and important circuits a wire of No. 4 gauge, the weight of which, per mile, is about eight hundred pounds; in some instances, however, No. 3 is used, the weight of which is about nine hundred and forty pounds.

20. GALVANIZED WIRE.—It is the opinion of Dr. Militzer, technical counselor of the Austrian telegraphs, that it is inexpedient to galvanize wires; and that the advantages to be derived, as compared with its disadvantages, do not compensate for the increase in cost. In Austria a wire of very superior quality is used, which is made from Styrian iron. In undergoing the process of galvanizing it loses, as does all wire, both in strength and pliability, while its cost is increased about 50 per cent. At a cost no greater than that of the galvanized wire, a wire half again as large, and, consequently, of 50 per cent. greater conductivity, an ungalvanized wire may be used; or, to put it differently, three ungalvanized wires cost no more than two galvanized wires of equal size. The wires are drawn in long lengths, and the joints are carefully soldered. If the quality of the wire is superior, and it is well annealed, especially when the larger sizes are considered, it is questionable whether the several advantages of greater durability, improved appearance, &c., possessed by the galvanized wire, compensate fully for the increased expense of its manufacture. At all events, the opinion of so eminent an authority as Dr. Militzer is worthy of careful consideration. Austria, finally, is the only country, according to my observation, in which plain or ungalvanized wires were employed. By way of comparison, it may be as well to state that more than half of all the wire used in America is of No. 9 gauge, the weight of which is three hundred and twenty pounds per English mile; a portion of the balance is No. 8, weight, three hundred and eighty pounds per mile; perhaps 3 per cent. is No. 6, weight, about five hundred and forty pounds per mile; and some No. 10, weight, about two hundred and seventy pounds per mile.

21. GALVANIC BATTERIES.—The Prussian government exhibits at Vienna the Callaud elements, of a pattern very similar to those generally in use in this country. The French exhibit the same. The Callaud, as incidentally remarked, is a modified form of the Daniell. The Austrian government employs another form, known as the Meidinger. The French, likewise, employed at one time the sulphate of mercury element, known as the Marie-Davy, and the peroxide of manganese element, or the Leclanché; but neither of these exclusively.

In one form or another the Daniell element has been employed for telegraphic purposes in all European countries, from the introduction of telegraphy to the present. The several forms in question are the Minotto, in which a layer of sand, about four inches in depth, rests upon the sulphate of copper; the Meidinger and the Callaud, in which the separation of the two solutions is effected by their difference in density, and the Daniell proper, in which the two solutions are separated by a porous cup. For telegraphic purposes the form of battery at present most

generally employed is the Callaud, which has been adopted to the exclusion of all others by the governments of Prussia and France.

22. The battery used on the experimental line of Professor Morse, between Baltimore and Washington, was the Grove, which has been used almost exclusively by American Telegraph Companies up to this date. The electro-motive force of the Grove is about twice that of the Daniell, while its resistance is not more than half that of the latter. These properties combined produced an effect, when the Grove element was used for a sounder or Morse register, of manifesting roughly about four times the strength of the Daniell. Had the instruments, in the first place, been adapted to the Daniell, by winding the magnets with a smaller-sized wire, the strength of the Grove would then have shown itself to be approximately only about double that of the Daniell. But while the strength of the latter element is but one-half that of the former, it is found to be ample for all the needs of practice. The cost of the Grove is about double that of the Daniell; that is, one cell of the former will cost as much as two of the latter element; while to obtain the same electro-motive force the expense, which would involve the use of two cups of the one form for one of the other, would be about equal.

The advantages of the Daniell element are:

First. Very decided on the score of economical maintenance; inasmuch as, compared with the Grove, the maintenance of the Daniell, including both labor and materials, does not involve one-fourth the expense of the former.

Second. The Daniell possesses an advantage on the score of constancy. After the Grove is set the strength of the battery runs down very rapidly, so that as a consequence every instrument in the circuit requires adjusting to the diminished force of the current, say as often as once per hour.

Third. There are no disagreeable or unhealthy fumes evolved from the Daniell, a condition unavoidable with the employment of nitric acid in the Grove. Within the experience of the writer four battery-keepers have died in the city of Philadelphia of lung disease, contracted in all probability from this cause.

The improvement effected in the Daniell cell by dispensing with the porous cup is a most advantageous feature, seeing that it accomplishes the more perfect separation of the liquids, and reduces the consumption of material to a minimum. It is an unavoidable feature in all batteries that only a portion of their material is utilized. A Grove when set without closing the circuit soon exhausts itself by local action. The Daniell continues to operate until a complete intermixture has taken place between the several solutions, which shortly takes place through the porous cup, when its action, so far as the instruments are concerned, ceases. Local action then ensues, and the consumption of zinc goes on at a greater rate than before.

23. For an equal amount of work performed, it is probable that not one-

quarter as much zinc is consumed in the Callaud as in the Daniell cell, a difference which is to be ascribed solely to the more perfect separation of the solution in the former. It is true that the internal resistance of the Callaud is greater than that of the Daniell, but this objection is overcome by an improvement known as Lockwood's; a device which consists in permitting a portion of the copper-plate in the form of a spiral wire, to extend upward into the zinc solution. When this spiral is brought to within an inch of the zinc plate, the resistance is reduced to an average of one unit per cell. By reducing the resistance to this point, it permits of many wires being worked from one battery, and the experience of operators has shown that the more such a battery is worked the less will be the tendency of the sulphate of copper solution to rise and become mixed with that of the zinc. It must be premised that the presence of the copper spiral as above indicated, does not in the least detract from the strength of the battery.

Another noteworthy improvement of the Callaud is the device of covering the surface of the liquid with paraffine oil to prevent its evaporation, a function which is performed most effectually. It also serves to prevent the formation of crystals of the zinc-salt from occurring on the surface, and in addition it completely insulates the battery. It has been objected to the use of paraffine oil that it adheres to the zinc when taken out for cleansing or renewal, as well as to the blue-stone, when this is dropped in to replenish the battery. These difficulties are, however, very simply overcome. If the zinc is not permitted to dry, but is immediately rinsed on being removed from the cell, or if the blue-stone is simply wetted with water before being dropped through the oil, no oil will adhere to their surfaces.

This form of battery is peculiarly adapted to the American system of closed circuits, and had it been adopted in the United States when first it came into use in Europe, not only would it have resulted in the saving of hundreds of thousands of dollars, but also in the avoidance of many inconveniences, and the production of much better effects.

24. Measures of resistance.—Breguet, of Paris, exhibits a set of resistances adapted to the French system of measurement, and having the mercury unit as a basis. Ten of these units are equal to one mercury unit; Digney, of Paris, exhibits the same in portable form, as they are employed by the French and Swiss governments in the telegraph service.

The Prussian department has resistance coils representing from one to ten thousand of the mercury units, as manufactured by Siemens & Halske, of Berlin. Siemens Brothers, of London, exhibit the same. There are in use at present two systems of resistance measures, to wit: the British Association, or absolute unit, and the mercury unit, which represents a prism of mercury of one millimeter in cross-section and one meter in length. The B. A. unit represents the resistance through which a unit of work is performed, in a unit of time, by a unit of electromotive force. To establish the exact value of this resistance is a diffi-

cult matter, and a subject upon which experts differ from each other; and resistance coils, having this resistance as its representative, or basis, differ very materially from each other. In view of these difficulties, the mercury unit was adopted as the standard of electrical measurement by representatives of the several European governments assembled at Vienna in the year 1868, which decision was affirmed at a similar convention held in Rome about a year ago.

25. THE MORSE ALPHABET.—The alphabet as used in America was, in the early history of the telegraph, improved materially by the Germans. These improvements consisted in doing away with the spaced letters, or those letters formed of dots with unequal spaces between them; and in introducing other changes whereby the characters were made more easily legible, and the liabilities of error in reading were reduced. The original characters of Professor Morse, not used in the European alphabet, are the C, O, R, Y, Z, and the character &.

The changes introduced by the Germans were so manifestly improvements upon the original, that they were soon adopted by all the other countries of Europe, and this modified alphabet is now in universal use except in North America.

About the year 1847, when the telegraph reached Saint Louis, and before railroads had extended into the Western States, an election for United States Senator was held in the State of Missouri. The name of the successful candidate was telegraphed and published in all the Eastern papers as Grier; his real name, however, was Geyer. The names Grier and Geyer appear to be very similar when written in the American Morse characters, inasmuch as there are the same number of dots and dashes and spaces in each, the variation consisting simply in the length of these spaces, and that of very slight degree. When written in the European Morse alphabet, these names have so little resemblance that the reading of the one for the other, by an operator, would be an inexcusable blunder.

In the American alphabet, again, the characters T and L are each a dash, differing only in length, the consequence of which is the frequent mistaking of the one for the other. In the European alphabet they bear no resemblance. It is fair to presume that the errors growing out of the misinterpretation of these characters more than equal those from all other causes combined.

Professor Morse advocated, many years since, the adoption, in this country, of the changes made by the Germans. It can be effected in a day precisely as it was accomplished in Europe. England was the last country to adopt the change, which was effected by the mutual agreement and concerted action of the three telegraph companies at that time controlling the business.

26. PRESERVATION OF TIMBER.—In the mountainous districts of France, Germany, and Switzerland there flourishes a species of evergreen or fir, a tree very straight in its growth, and otherwise well adapted to serve for telegraph-posts, with the one drawback, however, that it decays

very rapidly. This difficulty, however, has been measurably overcome by the preservative process of Boucherie, which consists in injecting the wood with a solution of sulphate of copper. When prepared according to this process, this timber used for telegraph-posts is made to last from fifteen to twenty years. The posts are subjected to this process in the forest directly after cutting and while yet full of sap; the expense of thus treating them varying usually from one to one and a half dollars per post. In many regions of the United States there is a wood of very similar character to that above named, which is known as hemlock or spruce, and which, on account of its perishable nature, has very little value as a timber. It is probable that this species may be found serviceable at some future time, if prepared for such use by Bouchereizing. The wood is more readily and more perfectly protected in proportion as it is porous and rich in sap. After undergoing the preservative process the timber is permitted to season, which proceeds very quickly, when it becomes very light and portable, an advantage, inasmuch as the posts are handled and transported with greater ease. By far the greater number, if not all the posts of the French, German, and Belgian telegraph service are now subjected to this preservative process. There is no timber in those countries which is naturally as durable as the American chestnut, which is quite abundant throughout the Middle and New England States, or as the white cedar of the Northwest. At the present time it is probable that the use of these timbers in their natural state would be more economical than resorting to the process of Boucherie.

27. Modern line construction.—The number of posts per mile usually employed in this country is double the number used in Europe. The greatest number used in England is twenty for ten or more wires. In France it is about sixteen; yet their lines are very substantially built.

If a No. 8 wire is stretched one span at a time, and pulled up to the full strength of two men, and the poles are thirty or more to the mile, such lines will be so tight as to break from contraction in cold weather, provided the line has been strung during the warmer months. On curves and angles this contraction forces the posts out of line; but if the posts are but twenty or less to the mile, two men cannot pull up the span so taut as not to leave sufficient curve or slack in the wire to counteract the strain which it will probably suffer from contraction during the cold season. The breaking-strain of a No. 8 wire is from twelve hundred to eighteen hundred pounds, according to its quality. To bring up the span to within twenty inches of being straight, requires a tension of about four hundred and twenty pounds where the poles are stationed twenty to the mile. The same force will bring up the span to within twenty-four inches of being straight where sixteen poles to the mile are employed. Such a strain will split or detach any ordinary wood-bracket or pin, when the wire is strung one span at a time, and tied or fastened to the common glass insulators. The support of the French insulator is a wrought-iron bracket, weighing three and a half

pounds, and has sufficient strength to sustain a tension of one thousand pounds without bending or breaking. This system of a reduced number of posts is not practicable with the common glass insulators of our country. They are of too frail a nature. As used with thirty to forty poles to the mile, a large percentage of them are broken in suspending the wires, so much so that not unfrequently as much as 30 per cent. goes to waste in this manner.

It has been objected to the system of a reduced number of posts, that the wires are more liable to be broken by sleet, but this is by no means a necessary consequence. A No. 8 or No. 9 wire of good quality will sustain the necessary tension, say three hundred and fifty to four hundred and fifty pounds, and an additional strain of one thousand pounds without breaking, a strain far greater than that which the sleet is able to bring to bear upon it; but if fifty posts are used to the mile, with wires pulled tight, the sleet will be able to break every span. With sixty posts to the mile, to avoid this very difficulty over the Alleghanies, the writer has seen the wires entirely prostrated by sleet, owing to the tight stretching of the wires. It has likewise been urged that the wires are more liable to be crossed and twisted by high winds, but with a secure fastening at the insulators, such a result does not follow. The weight of the wires keeps them at their proper distance apart; and when moved by the wind they "swing and keep time together."

The illustration (Fig. 2) herewith appended, shows the method

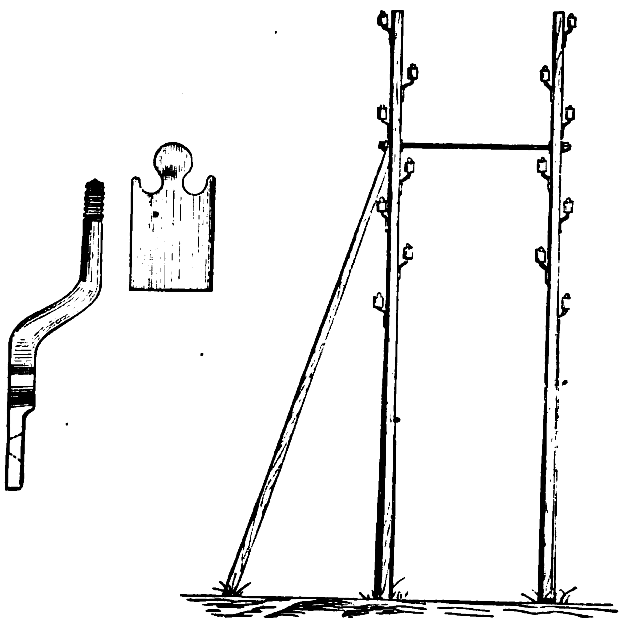


FIG. 2.

adopted by the French in supporting their wires. Two poles are set about seven feet apart, and in a line at right angles to the direction of the wires. These posts are firmly secured to each other by an iron bar,

one and a quarter inches in diameter, fastened with screw-nuts. Upon the side bearing against the strain of the wires is placed a third post, in the form of a brace. This brace is omitted where the wires are on the straight line, but is erected when this is otherwise. This arrangement forms an immovable support, capable of safely carrying twenty or more wires.

The illustration (Fig. 3) shows the Austrian method of accomplishing the same purpose. By placing the cross-arms upon each side, and attaching them to the posts with screw-bolts, a structure of great strength is obtained, and at a less cost than upon the French system.

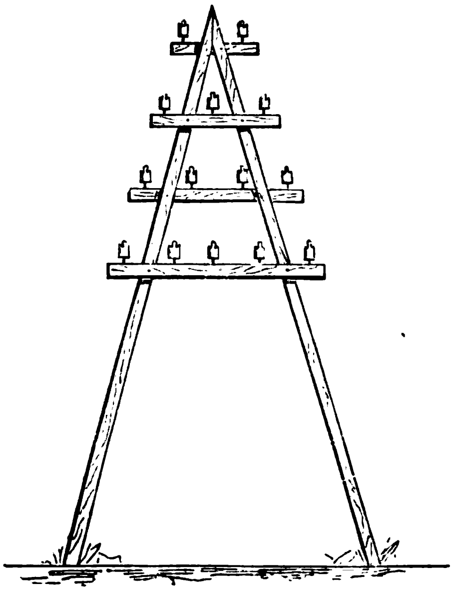


FIG. 3.

28. INSULATORS.—The exhibit of insulators in the Prussian department of the Vienna Exhibition, comprising more than twenty different styles, include in the list the earlier kinds, as well as those at the present time in use by that government. That employed at present was first designed by Colonel Chauvin, formerly director of the Prussian telegraphs. It has a double shed or drip, of greater height than is usually employed, and is placed in an iron bracket of great strength, weighing about three and a half pounds, so formed as to prevent the under surface of the instrument from being wetted by dashing drops of rain.

The first insulators employed on the continent were of glass, and not unlike those in use at the present day in this country. The observation was, however, soon made that the instruments would afford better results when constructed of porcelain. The choice of this material for the above purpose, however, involved the necessity of constant care in selecting the good from among the defective, inasmuch as its quality varies greatly even with pieces from the same burning. The defective

pieces are porous, not having received sufficient fusion in the kiln, and consequently are readily permeable to moisture. To detect these defective pieces, for rejection, requires the use of astatic galvanometers. When these precautions are observed, a much better material for insulators than ordinary glass is obtained; besides which, it possesses greater strength, and is susceptible of being molded into forms more suited to the purposes of practice than is glass.

29. The form of instrument known as the Prussian insulator is manufactured largely in France and Belgium. It is used in Germany, France, Italy, Norway, Sweden, and Russia. Those used in Germany are manufactured in Berlin. The French manufacturers make these insulators of the same material as is employed in the manufacture of the French china ware. With this single exception, material quite as good is made in this country at the Trenton, N. J., potteries as is made in Europe; but porcelain has never been used for this purpose with us, and consequently the method of selecting the good from the bad by the use of astatic galvanometers is unknown. As made in France or Prussia, the cost of the Prussian insulator and its iron bracket is about fifty cents each.

The firm of Siemens Brothers, of England, exhibit all the varieties of insulators manufactured in their works, from the early history of the telegraph. Their exhibit includes all or nearly all the forms of this instrument used in England, or manufactured there for export. Among the latter is the Brooks insulator, the invention of the writer, very similar to those made in the United States.

30. While in Europe, in the year 1867, the writer procured sets of insulators of the following nationalities: Würtemberg, Italy, Sweden, Denmark, Russia, Prussia, France, Belgium, Switzerland, Austria, and England. Of the last-named nationality there were three standard kinds, viz: the United Kingdom's, the British and Irish Magnetic Telegraph Company's, and Varley's Double Inverts. These instruments were procured for the purpose of galvanometric measurement and comparison with those of this country, including the form manufactured by the writer. Of these several instruments one hundred and nine separate tests, during the occurrence of rain, have been made and recorded within the past six years, the results of the same having been quite uniform. The following is a summary of these results: The instruments of the French-Prussian pattern gave the best results, exceeding the best of the English insulators in the proportion of four and a half to one; and exceeding the poorest English in the proportion of five to one. Of all the European instruments the English proved to be the poorest, their performance averaging within a fraction of that of the common glass insulators in use in this country. Had the average of two hundred measurements been taken, so as to include the lighter rains, which did not seriously affect the other insulators, the average performance of the English insulators would have been much lower, even below the

American glass insulator, inasmuch as a moderate rain produces a much more serious effect upon them.

31. There is no function in its operation which so seriously affects the economy and efficiency of the telegraph as its insulation. It is by no means uncommon, upon a wet day, for a person to leave a dispatch at the telegraph-office in Philadelphia, directed to New York, and thereupon to take the cars and arrive before the dispatch.

To transact the business between New York and Philadelphia, there are, probably, as many as forty wires. On a fair day, the entire business can be executed upon four wires, with the use of the printing-instruments, with an average delay of less than five minutes to each message. But as a result of their very defective insulation, where they have been exposed to the effects of a few hours' rain, the whole of the wires, worked to their utmost capacity, are insufficient to save the business from hours of delay.

The French, in virtue of the better system of insulation which they have adopted, are able to effect far more upon one wire between Marseilles and Paris, or Lyons and Paris, or Havre and Paris, than the English between London and Liverpool. In equally wet weather, the superiority of the French over the English practice, measured by the amount of work which each is able to perform, will be in the proportion of three to one, at least, and, more probably, in the proportion of five to one. On all the leading routes in France, the Hughes printer is worked, in the rain, at full speed. On corresponding routes in England, it is only possible to work the Morse instrument, and that at a very reduced rate of speed, in spite of the fact that the English have the advantage of larger wires, greater conductivity, and shorter circuit-distances.

32. The French work two wires in all kinds of weather, direct from Paris to Berlin, with the use of the Hughes printer; but are unable to work direct to Vienna, because of the inferior character of the insulation of the Swiss wires, upon which a common glass insulator is in use. The Swiss authorities admit the imperfection of their insulation, and are at present engaged in remedying the evil by introducing the Prussian insulator, as manufactured at the Belgium potteries. The sample specimens of this insulator, shown to the writer in Berne, were somewhat inferior to those manufactured in Prussia.

They are unable to work from Paris to London with the Hughes instrument, on account of the defective character of the English insulation, but can work from Paris to the English side of the channel, where re-transmission is made.

33. In his Handbook of Practical Telegraphy, Mr. Culley gives, as the insulation per mile of a No. 4 wire, in rain, between Dublin and Belfast, while "working well," 91,900 units, and that of a No. 8 wire in the same circuit and under the same circumstances, as 112,000 units. Lines of any length, say, two hundred miles, cannot be worked with such an escape in this country with our American system of closed circuits; yet there are wires in use by our railroad companies of that length, with

three times the resistance of a No. 8 wire, added in the form of relays, working well in rain.

The English endeavor to overcome the effects of bad insulation by the use of larger wires, upon the following principle: If a wire of a given size or weight per foot works up to a certain capacity one hundred miles in the rain, then a wire of twice the size and weight can be worked two hundred miles to the same capacity in rain, making allowance for the increased number of insulators. If the same number of posts were used on the larger wire, that is, half the number per mile, then the larger wire would have exactly equal capacity with the smaller one of half the length. To mitigate the effects of their bad insulation, the English have ground-wires attached to their posts to carry the leaking current to the earth, instead of into the other wires or each other. They also have a separate battery for each wire. This necessitates the employment of forty thousand cells of battery at the central station in London, a sufficient number, used as main batteries, to work all the lines of telegraph in Europe, provided the same were properly insulated.

Theoretically considered, there are fewer cross-currents and disturbances in rain, when working with a separate battery for each wire, than when a number are worked from the same battery, but when the wires are as well insulated as those of the French, this difference is practically inappreciable.

The English, in their telegraph practice, have labored under the disadvantages of bad insulation from the beginning. On this account, the old needle-system was retained in use by them for twenty years, simply because the condition of their wires would admit of no other. Five per cent. of the current leaving the battery will operate the needles at the other terminals; but the speed attained upon the needle-system is no more than half that of the Morse, while the liability to error is twice as great. The condition of the wires in England at this day is improved to the extent of admitting the Morse system of open circuits, but to operate them upon the American system, which is far more economical and convenient, would be impracticable.

34. The extent to which the Hughes printing instrument is used in England and in France, affords a good standard of comparison by which we may judge of the comparative excellence of the insulation of the wires in the two countries.

In the London central station there are employed—

Hughes printers	12
Automatic	40
Ink-recording Morse	240
Duplex	20
Single needle	130
Sounders	12
Bright's bells	6
Total instruments	460

In the central station at Paris, there are employed—

Hughes printers	70
Morse ink-recorders	30
Total instruments	100

The average daily business of Paris proper, not counting repeated messages, but only those originating in Paris to go to other points, and those delivered in that city, amounts to as much as 12,000 dispatches; at times it has reached as high as 15,000.

The average daily business of London, as the writer has been informed, is 15,000 dispatches, but the repeated and local dispatches of the London central station reach upon an average 15,000 dispatches. The statistics of this kind of business at Paris, the writer was unable to obtain, but it is trifling when compared with that of London, since the system of transmission with pneumatic tubes is employed in Paris to a much larger extent than in London.

If the insulation is inferior, the needle system can be operated with the least difficulty; next in order is the open-circuit Morse system to which reference has been made before; while to be able to use the Hughes printer necessitates comparatively perfect insulation. For this reason the Hughes instrument is little used in our own country.

In clear weather, the condition of the wires permits of its employment with all of its advantages, but when the wires are under the effects of rain, these instruments must be placed aside and the Morse substituted, and the dispatches are transmitted at a very reduced rate of speed.

To have two sets of instruments, the one for fair and the other for foul weather, is neither advisable nor economical; so that in this country as well as in England the printing instruments are used but to a very limited extent, and even this limited use is confined to the shortest circuits and the largest wires.

35. Underground wires in cities.—The wires are run under ground in the cities of Berlin, Dresden, Breslau, Dantzig, Stettin, Hamburg, Bremen, Cologne, Frankfort on the Main, Mayence, Carlsruhe, and other large cities and towns of Germany, and in Geneva, Lausanne, Berne, Neufchatel, Zurich, Winterthur, Schaffhausen, Saint Galle, and Lugano, in Switzerland. In nearly all the cities of Europe neither posts nor wires are visible, but the system of underground cables is adopted instead. These cables contain from five to seven conductors each, insulated with gutta-percha, and the whole protected with an armor of iron wires. This system has shown itself in practice to be both economical and reliable. There are now in Paris working lines that have been buried for twenty years, and which have been the cause of little or no expense except their first cost. It is especially worthy of note in this particular that during the reign of the commune, when almost every institution of public utility was destroyed, not an underground wire was disturbed.

There are, probably, five times as many wires in our cities as in European cities of equal size and importance, a condition which is attributable entirely to competition between rival companies, and the consequent multiplication of needless branch offices. One of the most obvious results of this condition of things is that our finest avenues are obstructed, and their appearance marred by unsightly posts and wires. In no part of Europe, not even in the by-ways of the country, do we see such ill-prepared and ill-shaped posts, standing so persistently out of perpendicular, as may be seen in any of our finest thoroughfares. Expensive flagstones and pavements are broken up and injured to make way for these unsightly fixtures, from which, from present indications, there seems to be no relief.

Another disadvantage of this system resides in the fact that the posts so exposed are frequently destroyed by fires, &c., and the working of the wires interrupted when they are most urgently needed.

Wires on mountains are often broken by accumulations of ice and sleet. Our wires to the Pacific have been interrupted from this cause for weeks. In Switzerland the passes of Saint Gothard, the Simplon, and others are crossed by cables laid on the ground, and telegraphic communication effectually preserved by that means. The French accomplish the same object by the use of an iron wire seven millimeters in diameter. This wire is of such size and strength as to withstand any accumulation of ice and sleet.

36. PNEUMATIC TUBES.—The delivery and transmission of dispatches, in the cities of London, Paris, and Berlin is greatly facilitated by the systematized employment of pneumatic tubes in connection with the telegraph. The central telegraph station of Paris is not located in a business mart or thronged center, but is central in position, or equidistant, as regards those business marts. In our own large cities such stations are invariably in or near the business centers or exchanges.

The following details of the operation of the pneumatic system in Paris may be of interest. Within a certain radius of the Paris central station the dispatches are delivered by messengers. Beyond the central station there is a circle or zone reached by pneumatic tubes, embracing eleven stations. Beyond the circumference of the circle reached by the tubes are other radiating points in connection with the central station by local telegraphs. Of the telegraph business of that city probably no less than four-fifths of it is reached or handled with the aid of the pneumatic system. As aids or auxiliaries to the operation of the tubes, the latter system stands in connection with local telegraph lines in much the same manner as the railways employ the telegraph to control and facilitate the movements of trains.

The number of branch offices in Paris, where, next to London, the largest business of any city in the world is transacted, is less than twenty, but for promptness and efficiency the system of working there employed is worthy of highest praise and emulation. As they come

from the printing instrument the printed slips are cut, pasted on a sheet, folded, put into an envelope, sent through the tube, a distance of three-quarters of a mile, and placed in the hands of a messenger, all within a space of time averaging not more than four minutes. The chief object which appears to be sought is *dispatch*, and not, as is unfortunately the case in this country, to make or obtain business. When there were but three telegraph offices in Philadelphia, a main office on Third street, with a branch in the Exchange, and one at the Continental Hotel, there was no competition between rival lines or offices; now there are in that city one hundred or more branch offices. The only motive for the establishment of so many branches is the effort to divert business from opposition lines, and the expense necessarily incurred is enormous; and the public are ultimately the bearers of this burden in the form of excessive rates which are charged.

A branch office of some one of the telegraph companies may probably be found, upon an average, within five minutes' walk of any portion of the city of Philadelphia. But as an indication of their inefficiency in meeting the needs of the community, it is not saying too much when it is asserted that, should the sender of a dispatch avail himself of the street-cars, and carry his dispatch in person to the central office, instead of directing himself to the nearest branch office, his message would, as a rule, reach its destination much sooner than if he had adopted the latter alternative.

37. THE MONOPOLY OF THE TELEGRAPH.—The rates of telegraphing in this country have always been high, yet but few of the stockholders, or those who furnished the money to construct the lines, have ever received any return for their investments. In most cases the Morse patent was sold to individuals, who organized companies, received subscriptions to stock, and constructed the lines, deriving personally large profits thereby. Usually about three times the amount of money necessary to build the lines was subscribed by the stockholders, and an equal amount of stock was issued for the patent; so that those organizing the companies not only derived large profits from the construction of the lines, but also held the controlling interest in the stock. By this mode of procedure, a few individual speculators have each succeeded in realizing far greater profits from the Morse patent than were ever realized by its inventor.

As the railway system of the country was developed, the telegraph became indispensable as an auxiliary to its operations. The privilege of the telegraph, however, the railroad owners could only procure by granting exclusive rights to the telegraph company to set the poles and string the wires upon the line of the road. These rights were made perpetual, and were of more avail in securing the monopolizing of the telegraph than the patent itself, since, among other things, lines of telegraph upon highways in this country are expensive to maintain. Again, these exclusive rights have been greatly strengthened by the lib-

eral use of the franking privilege, giving free transmission to the messages of railway officials, legislators, lobbyists, editors, and correspondents of the press. The establishment of the New York Associated Press has as its chief object, so far as the telegraph company is concerned, to silence the criticism and secure the influence of those journals enjoying its advantages, in the matter of preventing governmental interference. By the exclusive transmission of news at reduced rates to that association, the members of the latter possess a monopoly of journalism, to the extent of publishing a daily paper with news from abroad and from all parts of the Union. No journal is permitted to enter the association or to compete with them.

Of the influence of this monopoly, the following instance will give an adequate notion. The last journal to enter this association was the New York World. The value of this arrangement was then fixed by the other journals at $125,000. It is, therefore, to be expected that when such a value is placed upon its privileges, the influence of its participants will be strenuously devoted to the maintenance of the monopoly; and as zealously against the interference of Government in the interests of the people.

The journals constituting the Associated Press sell their news to the press in other parts of the Union, the latter being protected against competition by suitable arrangements with the telegraph company, the result being that no newspaper can obtain their dispatches and enjoy the privilege of the association, except upon payment to its members of such bonus as they may choose to impose. The daily journals outside of New York are thus in turn secured against competition in the early dissemination of news, and their influence in turn will naturally be exerted against any change which would be even remotely liable to affect their interests.

An arrangement of a very similar nature formerly existed in England. The influence of the entire press of that country was exerted to ward off government interference with its perpetuation. The journals of this country have repeatedly reproduced all the criticisms and strictures of the English papers on Mr. Scudamore, and those who were instrumental with him in bringing about cheap telegraphing in that country; yet, among the great class of its citizens who paid for their dispatches before the government took charge of the lines, and who pay for them now, Mr. Scudamore is the most popular man in England.

38. ESTIMATED COST OF NEW TELEGRAPH-LINES.—The Government has from time to time received estimates of the cost of new lines of telegraph. With reference to these, the writer is convinced that the estimates are, in the main, too high, provided that the best constructed European lines are taken as models. In these estimates, the number of posts specified to the mile is thirty or more. Twenty posts per mile is amply sufficient for any number of wires; more than that number is not only not advantageous, but positively detrimental, entailing in-

creased cost of maintenance. The greater the number of poles, the greater is the number of insulators required; this last item is therefore correspondingly too high by at least 30 per cent; the multiplication of insulators being in turn a positive disadvantage, since every such instrument upon a line is, theoretically, a leak, and hence the fewer the number employed, the less will be the loss of the current.

If the number of wires is no more than two for one set of poles, sixteen poles to the mile is ample. The estimates for poles and insulators are, therefore, for a much larger number than is required by modern and improved construction. The same estimate specifies No. 8 galvanized wire, with improved insulation. No. 11 wire, costing only about half as much as No. 8, will answer every purpose. Excepting the longer circuits, say for three-fourths of the whole number of miles of telegraph specified, the item for wire could be reduced by one-half, or the total estimate for wire by about 30 per cent. The number of miles of wire specified, one hundred and twenty-five thousand, if properly erected, would afford ample facilities for the transaction of any amount of business five times greater than is found to be required at the present day, with existing rates.

39. In Europe there are many more branch lines—lines extending off the line of railways—than in this country. There is a train, called the mail, which leaves nearly all the cities of the Union in the morning. This train makes many stoppages; and at some of the stations a carriage conveys the mail and a few passengers to towns not situated on the line of the road. There is scarcely a post-office of this description where a telegraph station would not be equally desirable, a desideratum which could only be attained by the systematic extension of branch lines.

For a line of one wire, twelve poles to the mile is all that would be required, a No. 11 wire (weight per mile two hundred pounds) is best adapted, and the cost of such a line will not be half as great as for one constructed with No. 8 wire and thirty-three poles to the mile, the kind of line for which estimates have been made.

In most of the European countries, such minor stations are maintained for the convenience of citizens, just as there and in this country minor post-offices are maintained. Telegraph stations, at such points, should, with equal propriety and utility, be erected and maintained in this country. Should the Government, through its agents, propose to furnish the wire and instruments for such branch lines, the citizens would, without doubt, in most cases, be glad to provide the poles and labor and supply the operator. The receipts from such minor stations might be appropriated to the citizens of the place to go toward providing a fund for the maintenance of the poles, a portion of the same going to the person in charge of the instrument. Upon such terms, some person could readily be found wherever there was a postal station who would be willing to take charge of the instrument. Again, as the instrument most

suitable for such stations is the ink-writer, the difficulty of finding an operator will be materially lessened, or altogether obviated, since any person of average intelligence can learn to operate and to read from that instrument readily in a day by earnest application; a fact which when appreciated would, beyond question, make such a post very desirable, for an accomplishment of this kind would be sought by many, with the object of making such knowledge of future benefit rather than of immediate profit. As its share, the Government could appropriate the receipts from the return business, which could constitute a fund from which to repay the outlay for wires and instruments. It is by the systematic development of a system similar in its tenor to that above suggested, that France and Germany are covered with a veritable net-work of wires, by which the telegraph is brought *in fact* within the reach and means of the people of every portion of the territory of those countries. In this country there are thousands of postal stations that could be reached in this manner without cost to the Government.

Again, so far as the item of labor is concerned, the trunk lines can be built and maintained by the railway companies for less than one-half the money that the telegraph companies expend for this purpose. This the railroad company should do, and be paid for it, the same as for carrying the mails, or performing any other service for the Government.

40. The foregoing suggestions are the outgrowth of many years' experience with the telegraphic system, as practiced at home and abroad, and, though crude and imperfect, the writer is convinced that they must form the basis of that system which aims to bring the telegraph veritably within the reach of the people at the least public cost. The writer entered the telegraph service in this country in the year 1845; first in the construction of the line between Baltimore and New York, and afterward in the construction of the line between Philadelphia and Pittsburgh. The line between Washington and New York was known as that of the "Magnetic Telegraph Company." For one hundred dollars paid in, two shares, of one hundred dollars each, were issued to the subscribers to stock. An equal amount of stock was issued to the patentees, so that for every one hundred dollars paid in there were four hundred dollars of stock issued.

At first two wires on one set of poles were the extent of its facilities, but the profits of the company soon enabled it to increase the number of its wires, as well as to pay its stockholders dividends of 12 per cent. on its capital stock. The stock of the company was subsequently very much increased.

For the line between Philadelphia and Pittsburgh, three shares of stock were issued for one paid in, and the stock was subsequently doubled, so that six shares were issued for one paid. This stock paid from 12 to 15 per cent. on its face when absorbed by the present Western Union Telegraph Company. The original rates upon which these dividends were declared were:

From Philadelphia to Washington, 30 and 2; now 40 and 3.
Baltimore, 25 and 2; now 30 and 2.
Wilmington, 10 and 1; now 25 and 2.
New York, 25 and 2; now 30 and 2.
Lancaster, 20 and 1; now 25 and 2.
Harrisburg, 25 and 2; now 35 and 3.
Pittsburgh, 40 and 3; now 40 and 3.
Cincinnati, 80 and 6; now 100 and 7.

To nearly every point from Philadelphia, as may be drawn from the foregoing, the rates of transmitting telegraphic messages have been raised; besides which, an extra charge is now made for delivery of the dispatches, which, formerly, were delivered free of charge. From the years 1845 to 1866, the writer was in the service of the telegraph in this country, either in the capacity of manager, director, or superintendent, save for the year 1851, when employed in Mexico in the construction of a line from Vera Cruz to the city of Mexico. Since 1866, he has twice visited Europe, and has given the subject much attention.

41. It is the profound conviction of the writer, and one which is shared by every independent observer who has given the subject careful attention, that we are far in the rear of all civilized nations in the matter of making the telegraphic service a popular medium of communication, and this, too, in face of the fact that almost every valuable invention and improvement connected with the telegraph is of American origin. There is no country in which the telegraph could be made so invaluable in serving public necessity and convenience as in the United States, where those having business or other relations requiring correspondence are so widely separated from each other, and in no country is need more inefficiently realized.

Finally, the writer may be pardoned for venturing a few words concerning the rates or charges for telegraphing in this country.

Take as an example a wire or circuit worked one thousand miles, on which circuit there are way-stations. If a dispatch is sent from one station to the next or nearest station, or less than fifty miles, the minimum charge for ten words is 25 cents, which only occurs where there is no extra charge for delivery and when the message is delivered within a short distance of the receiving-station.

It costs the telegraph company just as much to send this dispatch as to send one the entire length of the circuit, and while it is being sent over this short distance the balance of the line is idle or waiting; but, on the other hand, if a message is sent the entire circuit, the charge is one dollar or more, the actual cost of transmission being the same in both cases.

Take another example, in which the message is sent from one circuit to a parallel circuit, or from one circuit on to another, or where the dispatch requires re-transmission. The distance in such a case may be less than fifty miles, and the charges only 25 cents, yet the labor involved

and the time during which the wires are occupied in its transmission are double that of the case in which one dollar or more is charged.

It is obvious, therefore, that the theory upon which the telegraph company proceeds in its charges, is to measure the necessities or object gained by those sending dispatches, and not the labor and expense involved in their transmission. A letter is sent from one part of the Union to another—from Maine to Oregon—for 3 cents, but if the cost of transmitting letters be compared with that of transmitting telegraphic dispatches, there would be vastly more justice in regulating the charge for carrying letters by distance than in the case of the telegraph. If we were to compare the average distance that dispatches are sent in Canada with their average distance in this country, it would be found that this is greater in Canada than with us, inasmuch as the large cities and towns of the former country in which the bulk of the telegraphic business is transacted are farther apart than in this country. Canada, however, has a uniform charge of 25 cents for telegraphic messages, and the telegraph company makes dividends to its stockholders of 10 per cent. on a capital much in excess of what would build lines of modern and improved construction having three times their capacity

42. A proper telegraphic system would require wires extending from one extremity of the country to the other, but it is only a very small percentage of the whole number of dispatches that would require this long transmission.

With the improved construction of lines that will not be reduced in their efficiency by unfavorable weather, and that will admit of the use of printing-instruments, and by the adoption of the automatic processes for those circuits having the greatest amount of business, the writer can see no good reason to justify a charge greater than 25 cents for twenty words, and then pay a fair rate of interest on the capital expended in constructing the lines. If worked, then, with the simple object of defraying running expenses, a uniform charge of 20 cents would be ample.

APPENDIX.

CATALOGUE OF TELEGRAPH EXHIBITS AT THE VIENNA EXHIBITION.

UNIVERSAL EXHIBITION AT VIENNA, 1873.

CATALOGUE OF THE APPARATUS EXHIBITED BY THE IMPERIAL-GERMAN TELEGRAPHIC BUREAU.

General number.	Group number.	
		A.—HISTORICAL SECTION.
1	II	The electro-chemical telegraphic apparatus of Sömmering; the first practically developed in Germany; constructed in 1809.
2	II	Drawing of an apparatus invented by the Russian Councelor Schilling, in Cannstadt, in the year 1832; the first needle-telegraph.
3	III	The electro-magnetic-telegraph apparatus constructed by Gauss and Weber, in Göttingen, and used from 1832–1838. Belonging to this—
3*a*	III	The signal-sender, (by induced currents;)
3*b*	III	The signal-receiver, (bar-magnet, with multiplier and mirror;) and
3*c*	III	Telescope for reading off the deflection of the magnet.
4	II	The electro-magnetic telegraphic apparatus of Steinheil, Munich, 1837.
5*a*	III	Sending-apparatus of the dial-telegraph, constructed by Leonhard, in Berlin, 1845; in use between Berlin and Potsdam, 1847.
5*b*	III	Receiving-apparatus of the same.
6*a*	III	Electro-magnetic dial and printing telegraphic apparatus, made by
6*b*	III	Siemens, of Berlin; patented in Prussia, 1846.
7	III	Signal-apparatus for railroads by Siemens, 1847. (Exhibited in London, 1851.)
8	I	Circuit-closer of Siemens, 1847.
9	III	First gutta-percha press for the manufacture of insulated conductors with gutta-percha covering without seam. Model constructed by Siemens and assigned to Fonrobert and Bruckner. The numerous under-ground telegraph-lines built in Germany and Russia between the years 1847–1851 were prepared by machines constructed upon this model, as are also all the modern submarine cables.
10	I	Plate lightning-arrester; first used by Siemens in 1848, between Eisenach and Frankfort-on-the-Main.
11	III	Trough-battery of Siemens, 1849.
12	III	Dial-apparatus of Kremer, Nordhausen, 1849.
13	I	Call-bell for intermediate stations, by Kremer, Nordhausen, 1849.
14	III	Electro-magnetic needle-telegraph of Siemens, 1849. (Exhibited in London, 1851.)
15	II	Embosser of Siemens, 1849, (one of the earliest instruments constructed upon the system invented in America by Morse.)
16	I	Relays of the oldest construction, 1849.
17*a*	III	Double-pointed embosser, by Siemens, 1850. (Exhibited in London in 1851.)
17*b*	I	Polarized relay belonging to this, (oldest form, without steel magnet, the magnetic induction of the core and keeper produced by a branch current from the local battery.)

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
17c	III	Transmitting-key of the same.
18	I	Intermediate call-bell of Siemens, 1850. (Exhibited in London, 1851.)
19	III	Magneto-electrical machine with twenty-eight pairs of plates, employed by Siemens with signal-apparatus in 1850. (Exhibited in London, 1851.)
20	I	Relays used in Hanover, 1850.
21	III	Siemens's blast-igniter, 1850.
22	I	Old key used in 1850.
23	I	Wire-coil lightning-arrester by Siemens, 1850–1853.
24	I	Wire lightning-arrester with metal ground-plate, by Siemens, 1850–1853.
25	I	Point lightning-arrester, by Siemens, 1850–1853.
26	I	Ball-and-point lightning-arrester, by Siemens, 1850–1853.
27	I	Box-relay, by Siemens, 1851.
28	I	Vacuum lightning-arrester, by Siemens, 1852.
29	I	Polarized relay, with double-point embosser, by Siemens, 1852.
30a	III	Hand-perforator for rapid writing, constructed by Siemens, 1823. (Exhibited at the Industrial Exhibition at Munich until May 30, 1854.) The Warschaw, Petersburg, and other Russian lines, built by Siemens and Halske, were first furnished with apparatus upon this system.
30b	III	Sending-apparatus for the same.
30c	III	Receiving-apparatus for the same, (a Morse, with swinging-magnets.)
30d	I	Relay of the same, (with magnets.)
31	III	A one-German-mile resistance, by Siemens, 1854.
32	I	Polarized relay for induced currents, with two steel magnets, a straight electro-magnet, and swinging core, (without keeper,) by Siemens, 1854.
33	I	Polarized relay for induced currents, with two straight electro-magnets and steel keeper, by Siemens, 1854.
34	I	Plug-switch, for intermediate stations, used in 1854.
35	II	Original ink-writer, by John, Prague, 1854.
36	I	Relay, with swinging magnets and double windings, to be used with the double transmitter of Frischen and Siemens, patented in Prussia in 1854, with resistance-scale graduated for miles of copper wire of 1''' diameter, as they have been supplied by Siemens since 1848.
37	1	Polarized relay, with a horseshoe-magnet and steel keeper, by Siemens, 1855. (A construction much used to-day.)
38	I	Polarized relay, with steel keeper, by Siemens, 1855.
39	III	Double-induction machine, by Siemens, 1855; designed to produce induced currents (secondary currents) with fewer elements.
40a	III	Induction-coil made by Siemens, 1855, in the first experiments to produce Morse characters, with the aid of polarized relays, by employing short intermitting currents of equal duration.
40b	I	Induction-key. (Same.)
41	II	Morse apparatus, constructed by Frischen, 1856.
42	I	Alarm, with relay for currents of definite direction, by Borggreve, 1857, constructed for small stations, (in connection with post-office.)
43	I	Switch for intermediate stations, by Nottebohm; in use until 1857.
44	I	Switch for intermediate stations, by Nottebohm; in use until 1857.
45	I	Line-switch, by Nottebohm; in use until 1857.
46	III	Crank rheostat, with resistance of 1-50 German miles of iron wire of 2.1 lines diameter, 1857.
47	I	Commutator, by Nottebohm; in use until 1857.
48	I	Lightning-arrester, terminated by pillars, by Nottebohm; in use until 1857.
49	I	Lightning-arrester, with blades for stations with one line; in use since 1857.
50	I	Lightning-arrester, with blades for stations with two lines; in use since 1857.
51	I	Relay with horizontal magnets, by Nottebohm; in use until 1857.
52	I	Relay, by Borggreve, 1857.

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
53	I	Switch for intermediate stations, by Borggreve, which, with some trifling modifications, is still in use.
54	I	Switch for intermediate stations, by Borggreve, 1857; still in use.
55	II	Submarine-telegraphic system, constructed by Siemens in 1857 for the Red Sea cable.
56	I	Galvanoscope cut-off.
57	I	Crank-switch; still in use for various purposes.
58	I	Plug-switch; still in use for various purposes.
59	I	Plug-switch; still in use for various purposes.
60	I	Return-current discharger for submarine lines, by Siemens, 1857; first used in the Red Sea.
61	I	Relay with double-wound helices, for double transmission, by Borggreve, 1862.
62	I	Switch for intermediate stations, with apparatus and alarm, constructed by Borggreve in 1862, for the purpose of changing the direction of the current, for calling or for correspondence.
63	II	Writing-apparatus, constructed by Siemens, in which a small color-wheel, movable upon a universal joint, enters an open reservoir, the surface of which can be raised or lowered; patented in England, 1862.
64	II	Embosser of Lewert, Berlin, 1865.
65	II	Color-writer of Lewert, Berlin, 1865.
66	II	Graphite resistances, to regulate the resistance at intermediate stations; in use since 1865. They consist of graphite powder pressed into glass tubes, and are furnished of different sizes, from 500 to 2,500 Siemens units.
67	III	Automatic Morse type-register, by Siemens, 1865.
68	I	Switch for testing, by Elsasser, 1866.
69	I	Key for alternating currents; in use until 1866.
70	I	Lightning-arrester, by Elsasser, 1866.
71	I	Line-switch, such as have been in use since 1866.
72	II	Color-writer of Lewert, Berlin, 1868.
73	II	Polarized quick-writing apparatus, using color, with variable velocity, by Siemens, 1868.
74	I	Relay with movable core, 1868.
75	I	Key, with battery-commutator; in use until 1869.
76	I	Key, used from 1869 to 1871.
77	I	Plate lightning-arrester, by Elsasser; in use since 1869.
78	I	Galvanoscope, (after Varley, 1857;) introduced in 1857.
79	I	Polarized relay, with two horseshoe electro-magnets, two steel magnets, and two keepers, for use on lines with commutated currents by Siemens, 1869; constructed for the Indo-European line.
80	I	Galvanoscope, Siemens, 1869.
81	I	Key, used since 1871.
82	I	Galvanoscope, such as have been in use since 1871.
83	....	Map showing the German telegraph line in 1854.
84	....	Map showing the German telegraph line in 1860.
85	....	Map showing the German telegraph line in 1866.
86	....	Map showing the German telegraph line in 1872.
87	....	Graphical representation of the development of telegraphic communication and means of communication in Germany from 1854 to 1872.
88	....	Special chart of normal connections of telegraph-lines, 1872.
		B.—TELEGRAPHIC APPARATUS NOW IN PRACTICAL OPERATION, AND THEIR SWITCHES.
89	IV	Switch of a line for two end stations and one intermediate station The writing-apparatus are switched in the circuit directly without relay and local battery.
90	IV	Switch of a line on open circuit for two end stations and one intermediate station. The writing-apparatus are switched directly on the line; transmitting arrangement by Maron.

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
91	V	Switch of a line provided with Hughes's apparatus for two end stations and one intermediate station. The transmission is accomplished partly by means of the Hughes apparatus, after the directions of Jaite, and by the use of the automatic commutator designed by him, and partly after the directions of Maron, by means of two polarized relays, with the use of branch currents.
92	VI	Line provided with the automatic rapid-writer of Siemens, (key-perforator, sender, and receiver).
93*a*	....	Two battery-boxes for small stations, with Meidinger elements;
93*b*	....	attached to the wall at Tables I and XIII.
		C.—APPARATUS AND IMPLEMENTS FOR PURPOSES OF CIRCUIT-TESTING.
94	VII	Case and apparatus for the examination of under-ground lines (old).
95	VII	Testing-galvanometer, (needle suspended from a fiber of silk), with stand, (old).
96	VII	Testing-galvanometer, with tree-screw.
97	VII	Differential galvanometer, with tree-screw.
98	VII	Pocket-galvanometer.
99	VII	A variety of apparatus for testing-purposes.
		D.—LINE-CONSTRUCTIONS (ERECTED IN THE GARDEN.)
100	....	Pole furnished with iron line-wires, and armed with three porcelain insulators, with brass boxes in rubber packing-rings, of which— I. One main-line insulator is placed on top of pole on straight fork-bracket. II. Two branch-line insulators are on ∫-shaped fork-brackets.
101	....	Pole furnished with the simple porcelain insulators used on the first iron line-wire, of which one main-line insulator is on top of pole and two branch-line insulators on ∫-shaped brackets on the same level. (Mark: Porcelain insulators, 1851–1855.) At the lower part of this pole there are attached two porcelain bells, with cast-iron caps, such as were used in 1853. (Marked, Porcelain bells, with cast-iron cups, 1853.)
101	....	Pole armed with the so-called cast-iron insulators, with porcelain ring; in use from 1855 to 1857. (*a*) One main-line insulator on top of pole. (*b*) Two branch-line insulators on ∫-shaped brackets.
103	....	An arrangement of iron insulators as they were used and mounted 1855–1857. Two poles erected two or three feet from each other, and bound together at the top with brace; both poles are armed. One for the main-line, with cast-iron insulators, with porcelain fitting, upon the top of the pole. Two for the branch lines, with similar cast-iron insulators on ∫-shaped supports.
104	....	Disengaging apparatus, 1857. A strong column provided with brackets for main and branch line.
105	....	Pole furnished with Borggreve's insulator, (1857.) (*a*) For the main line, on top of poles, with straight supports. (*b*) For the branch lines, upon screw-supports. At the lower part of this pole there is a so-called "commission insulator," on ∫-shaped support, 1858. (This form of insulator was proposed by a commission charged with the task of determining the most practical form, &c., of insulators).
106	....	Pole furnished with the double bell first proposed by Chauvin; first used in 1858, and generally introduced in 1862. The pole is braced. At the lower part of pole there is— 1. double bell, with straight support, on cast-iron brackets; and, 2. One on wrought-iron angle-support.

Apparatus exhibited by the Imperial-German telegraphic bureau—Continued.

General number.	Group number.	
107	....	Testing-station, (still in use,) with double brackets of malleable cast iron.
108	....	Cast-iron strengthening-column, with three insulators, (until 1862.)
109	....	Wooden strengthening-column of modern construction, with ebonite tubes and double bells for three lines.
110	....	Double poles of modern construction.
111	....	Double standard of the form at present used.
112	....	Disengaging-pole armed with three double bells.
113	....	A station arrangement as furnished in 1866–1867.
114	....	The same, with ebonite tubes and double bells, of the construction employed to-day.
115	....	Arrangement for a tunnel-line.
116	....	Various samples of wire-connections, &c.
117	VIII	E.—EXHIBITION OF THE ROYAL BAVARIAN TELEGRAPHIC COMMISSION (AS PER SPECIAL ANNOUNCEMENT.)
118	IX	F. A map with nineteen plate-drawings, showing the arrangement of the Royal Würtemberg Telegraphic Commission.
		G.—EXHIBITION OF VARIOUS MECHANICS AND MANUFACTURERS.
119	X	*Lewert in Berlin:* (*a*) Two complete sets of apparatus for private telegraphic stations for use with battery on open circuit; the writing-apparatus with self-releaser. (*b*) A differential galvanometer. (*c*) Three pocket elements.
120	XI	*Gwilt in Berlin:* A line provided with Jaite's apparatus for two end-stations and one intermediate station.
121		The same: Two complete sets of apparatus for railroad telegraph-stations.
122	XII	*Nagle in Berlin:* One Morse. One Wheatstone's dial-apparatus. One railroad signal-apparatus. One complete Morse apparatus, with relay. Two Meidinger elements of different construction. Two insulators with supports.
123	XII	*Vogel in Berlin:* Several specimens of wire for winding electro-magnets and rheostats and office-wire.
124	XII	*Stock Company for Telegraphy in Berlin (formerly H. Shombürg):* The apparatus of Schneider. Three elements. Several insulators and porous cups.
125	XIII	*Wiesenthal & Co., in Aachen:* Three complete Morse apparatus, two with relays, one with polarized register, without relay. Three single Morse apparatus of different construction. One lightning-arrester. One railroad signal-apparatus, with bell-house and induction-apparatus belonging to it.
126	....	*Schönemann, of Munich:* House and hotel telegraph, on the wall over Table VII.
127	....	*Felton & Guilleaume, of Cologne:* Several specimens of cable, on the wall over Table VIII.

CATALOGUE OF APPARATUS EXHIBITED BY SIEMENS & HALSKE, BERLIN.

No.	
	A.—Measuring-instruments.
1	Mirror-galvanometer, with a periodic swinging needle
2	Universal galvanometer for the measurement of resistance and electro-motive forces.
3	Complete ship-galvanometer, with astatic needle, with protecting case.
4	Sine and tangent Boussole, with protecting-case.
5	Sine Boussole and differential galvanometer in leather fitting.
6	Tangent Boussole.
7	Battery-tester.
8	Universal resistance.
9	Resistance-scale from 0.1 to 10,000 Siemens's units.
10	Resistance-scale from 0.1 to 5,000 Siemens's units.
11	Resistance-scale from 0.1 to 100 Siemens's units.
12	Siemens's units in German-silver wire.
13	Complete magneto-electrical distance-measurer, for stationary erection at torpedo-works, &c., consisting of the observing-instrument with inductor and of the observing-instrument with indicator.
14	Complete portable bridge for measuring resistance up to one million Siemens's units.
15	Complete magneto-electrical apparatus for indicating the height of water-column, showing the height of water at any time and distance; consisting of inductor, with float and chain, dial-apparatus, and automatic alarm.
16	Water-meter for tube 150 millimeters wide, combined with—
17	Water-meter for 20 millimeters.
18	Water-meter for 12 millimeters.
19	Water-meter for 25 millimeters.
20	Water-meter for 40 millimeters.
21	Water-meter for 60 millimeters.
22	Similar apparatus for alcohol.
23	Complete electrical apparatus for measuring the velocity of the ball in the tube of gun, consisting of a measuring-apparatus, a gun, a battery of Leyden jars, and a volta inductor, together with battery for charging the same.
24	A periodic Boussole.
	B.—Telegraphic apparatus.
	I.—*Lightning-arresters.*
25–29	Lightning-arresters of various constructions.
30	Large plate lightning-arrester, at the same time a cut-off.
31	Same, medium size, and cut-off.
32	Same, small, and cut-off.
33	Combined lightning-arrester, with automatic cut-off, in glass protecting-case.
	II.—*Galvanoscopes.*
34	Hair-needle galvanoscope, for the indication of very short currents.
35	Galvanoscope in cast-iron case.
36	Galvanoscope in polished mahogany box.
37	Traveling galvanoscope.
38	Pocket-galvanoscope, with case.
39	Central galvanoscope.
	III.—*Relays.*
40	Box-relay.
41	Polarized relay.
42	Iron relay.
43	Relay with horizontal magnet.
44	Submarine relay.

Apparatus exhibited by Siemens & Halske, Berlin—Continued.

No.	
45	Core-armature relay.
56	Shortening relay for increasing the rapidity of communication, after v. Hefner-Alteneck.
	IV.—*Telegraph-keys.*
47	Key for commutated current, with contact-springs (submarine apparatus).
48	Noiseless key.
49	Cast-iron key.
50	Magneto-induction key.
	V.—*Plug-switches.*
51–53	Various plug-switches.
	VI.—*Crank-switches.*
54–58	Various crank-switches.
	VII.—*Writing-apparatus.*
59	Small so-called box (Morse.)
60	Large box (Morse,) with double magnet.
61	Normal color-writer.
62	Normal embosser.
63	Cast-iron embosser.
64	Submarine writing-apparatus.
	C.—COMPLETE TELEGRAPHIC ARRANGEMENT.
	I.—*Army-telegraphs.*
65	Complete apparatus for army use, with all belonging to it, packed in compact form.
	II.—*Telegraphs for railroad service.*
66	Complete railroad telegraph-station, with table-embosser, key, galvanoscope, and lightning-arrester.
67	Complete railroad-telegraph station, furnished with table, color-writer, key, galvanoscope, and lightning-arrester.
68	Complete railroad-telegraph, double station, with suitable table for receiving the batteries, and upon it, color-writer, key, relay, galvanoscope, and lightning-arrester.
69	Complete telegraphic apparatus, with color-writer, transmitting-apparatus, galvanoscope, and lightning-arrester.
70	Complete guard-station apparatus, with color-writer, key, galvanoscope, and switch, in protecting-case.
71	Complete railroad-guard-house telegraph, with (dry) color-writer.
72	Complete railroad-guard-house telegraph, writing with liquid ink.
73	Complete railroad-guard-house telegraph, with self-releasing action and alarm.
	III.—*Transportable telegraphs.*
74	Transportable color-writing telegraph.
75	Complete transportable color-writer, with key and galvanoscope in case.
76	Complete transportable ink-writer, with switching-arrangement.
	IV.—*Apparatus for instruction.*
77	Writing-apparatus for instruction and practice; may be used without battery.

Apparatus exhibited by Siemens & Halske, Berlin—Continued.

No.	
	D.—FIRE-TELEGRAPH APPARATUS.
78, 79	Automatic fire-alarm.
80	Completely-furnished fire-alarm, intermediate station.
81	Completely-furnished fire-alarm, central station.
	E.—PRINTING-TELEGRAPH APPARATUS.
82	Complete type-printing apparatus, after Hughes.
	F.—AUTOMATIC TELEGRAPHIC SYSTEM OF THE INDO-EUROPEAN TELEGRAPH-LINE.
83	Station-table, with polarized rapid-writing apparatus, commutating-key, hair-needle, galvanoscope, two switches, and resistance.
84	Rapid-writing apparatus for dispatches on perforated paper.
85	Punch-key for perforating the dispatch-paper.
86	Cylindrical perforating-apparatus.
	G.—MAGNETO-ELECTRIC DIAL APPARATUS.
87	Complete magneto-electrical dial apparatus in case.
88	Magneto-electrical dial apparatus, with alarm.
89	Magneto-electric dial apparatus (transportable) for military use, in suitable packing.
89*a*	Small magnet-dial.
	H.—APPARATUS FOR SIGNALING AND CONTROLLING RAILROAD-TRAINS.
90	Complete train-signal apparatus for attachment in the interior of the coaches.
91	Train-controlling apparatus, registering the running and stopping time of the trains, with watch in case, and—
92	A paper-strip numbering-apparatus.
	I.—RAILROAD-SIGNALS.
	I.—*Alarm for battery-current.*
93	Alarm with automatic interruption and automatic off-switching upon supports.
94	Alarm with automatic interruption for placing on table.
95	Same, large size, upon supports.
96	Same, in mahogany case.
97	Rattling-alarm, with clock-work.
	II.—*Call-bell for induction-current for the use of magneto-inductors.*
98	A cast-iron suspended induction-alarm, with two small bells, for outdoor use.
99	Same, with two large bells, for outdoor use.
100	Same, variously attachable.
101	Standing induction-alarm, with large bells.
102	Same, with small bells.
103	Same, with disk.
	III.—*Signal-bells for indoor use.*
104	Small house-signal bell, in case on brackets.
	IV.—*Railroad-station signal-bells.*
105	Station-bell, with two bells in iron protecting-case, with roof.
106	Same, with two bells on cast-iron bracket, zinc protecting-case.
107	Same, with a bell, in wooden cover.
108	Same, with two bells on cast-iron bracket for vibrating cut-off switch, in zinc case.

Apparatus exhibited by Siemens & Halske, Berlin—Continued.

No.	
	V.—*Signal-apparatus.*
109	Complete railroad signal-column (by Hefner-Alteneck).
110	Same, with vibrating cut-off switch and warning-signal (by Hefner-Alteneck).
111	Complete iron guard-house, with a bell and signal-disk.
112	Complete iron guard-house, with two bells and vibrating cut-off switch and warning-signal arrangement.
	VI.—*Magneto-inductors for signal-bells.*
113	A magneto-inductor, with eighteen magnets for direct currents, with four keys for four wires.
114	Same, with twelve magnets for direct currents, with three keys.
115	Same, with twelve magnets for commutated currents, with two keys.
116	Same, with six magnets for commutated currents, with two keys.
117	Same, with six magnets for direct currents, with one key.
118	Same, with four magnets for direct currents, with one key.
119	Same, with twelve magnets in desk, with two keys.
120	Complete mine-inductor, with key-button.
121	Magneto-electric-bell signal-sender.
	K.—RAILROAD BLOCK-SIGNAL SYSTEM.
122	Five electric block-signal apparatus, forming a continuous line, two apparatus as depot-apparatus, two as depot protecting-apparatus, and an intermediate apparatus.
123	Complete track control-apparatus, with track-switch apparatus; block-signal apparatus, with imitated semaphores, also with track-rails and rail-levers, (system of Frischen.)
123*a*	Electric block-apparatus for arriving trains.
124	Complete depot protecting-apparatus, consisting of a block-signal apparatus with commutated current-arrester and a block-signal apparatus, with arresting-lever for depot use, (the system of Frischen.)
	L.—DYNAMO-ELECTRIC MACHINES AND ELECTRIC ILLUMINATING-DEVICES.
125–126	Dynamo-electric blast-exploder, for sparks.
127–128	Same, for heating.
129	Dynamo-electric machines, for the generation of strong direct currents, (system of Hefner-Alteneck.)
130	Same, small.
131	Same, small.
132	Automatic electric lamp, for commutated currents, with parabolic mirror upon universal joint and triangular support.
132*a*	Same, for direct and commutated currents, (by Hefner-Alteneck.)
133–134	Two combined dynamo-electric-light machines, mounted upon a locomotive for service with this:
135	Electric hand-lamp, with Fresnel lens system, the last furnished by Messrs. L. A. Veitmeyer & Co., Berlin; L. Soutter & Co., Paris.
	M.—CABLE.
136	Collection of sample of telegraphic cables, from the manufactory at Woolwich.
	N.—LINE-APPARATUS.
137	Various insulators.
138	Various iron telegraph-posts.
	O.—CLOCK-WORK.
139	A complete representation of the manufacture of Morse registers, from the factory at Berlin.

Apparatus exhibited by Siemens & Halske, Berlin.—Continued.

No.	
	P.—BATTERIES.
140–142	Various batteries.
	Q.—LATEST CONSTRUCTIONS.
143	Chain rapid-sending apparatus, together with receiver.
144	Box type-sender for Morse's rapid writer (by Hefner-Alteneck).
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K.

EDUCATION.

E. SEGUIN.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

EDUCATION.

BY

E. SEGUIN, M. D.

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INFANT-EDUCATION.

CHAPTER I.

THE CRADLE AND THE CRÈCHE.

THE NURSERY; YOUNG MOTHER'S FIRST MANUAL; LESSONS FROM EXPERIENCE; PRE-EDUCATION; FORM OF CRADLE; ENLARGEMENT; USES; ORNAMENTATION; EFFECTS; NECESSITY OF THE CRÈCHE; NURSING A PROGRESSIVE ART.

"*Considerons l'espéce humaine comme un individu que la durée infinie de son existence permet de rapprocher sans cesse d'un type parfait, dont son état primitif ne donnait même pas l'idée.*"—CABANIS.

1. INTRODUCTION.—An inquiry into the conditions of popular education in several countries can only serve to furnish the elements of comparison between what is done at home and what is done abroad, in view of improving home education. In this light, the writer looked at the school-collections exhibited in Vienna, but soon perceived that the most important data were missing; some not being susceptible of transportation or of representation by specimens; others having been intentionally withdrawn. Withdrawn! why?

To educate children for themselves is rare in Europe, and it is considered rather Quixotic. The youth of the people are merchantable commodities, soon to be credited to the party which puts its stamp upon them. Therefore, where they are worth having, they are picked up as eagerly as nuggets. Priests pretend to teach them to think, yet care only to impose upon them a belief which implies obedience to their craft; Kaisers claim their direction, not to elevate them, but to put them among their droves of subjects; bourgeois and manufacturers give them a minimum of instruction, just sufficient to insure their working dependence, and to qualify their own sons to be fed at the public expense; while the workingmen themselves—demoralized by such examples—put their apprentices at menial employment, and cheat them out of their rightful professional training!

For these and other causes, Section XXVI of the exhibition was so incomplete as to seem to preclude, at first sight, the idea of making any report upon it. A second thought, however, encouraged the plan of searching the schools themselves for the facts missing in the Prater.

No doubt, the impossibility of visiting all the schools—rather, the possibility of seeing only a few—made it certain that such a report would be incomplete. But, considering that completeness is not the

sine qua non of human efforts, the writer thought of gathering, in and out of the *Welt-Ausstellung*, as many facts as circumstances would permit, and of forming from generalities a judgment, which subsequent observers could complete, confirm, or reject.

From this stand-point, we consider European children as in four groups: those who receive no education; those who do not receive the education they need; those who receive an education which disqualifies them for work; and those whose education prepares them for work. From another point of view, we saw that the European children enter the school younger, are trained longer, and are advanced farther than the Americans. As a consequence of this last contrast, we shall have less to say about the primary and grammar schools and more about the infantile and the professional. We will leave the other consequences to issue naturally from observation.

Since singularly strenuous and successful efforts have been made to overcome the apparently impassable barriers which separate from the world some afflicted children, namely, the deaf-mutes and the idiots; we will append an account, somewhat historical, but mainly philosophical, of these methods, in the belief that, being positive, they can be applied to ordinary children. Having no room for such an introduction, we would refer to the HISTORY OF EDUCATION, by Philobiblius, (Dr. L. P. Brockett,) as the best on the philosophy of the subject.

2. THE CRADLE.—At the Vienna Exposition (*Wiener Welt-Ausstellung*) there was a "*pavillon de l'enfant*," a room replete with the necessaries of the nursery—and also with its superfluities—intended altogether to represent the unbounded wishes of a mother for her baby's comfort and happiness. This palace of luxurious nursing did not lack silk, lace, and snowy linen; but it ought—in the estimation of the writer—to have been accompanied by a little manual of what is necessary to protect and to prepare life before nativity.

During this first period, the feelings come mainly through reflex impressions from the mother—a process which not only lays the foundation of health and vitality, but which forms the deeper strata of the moral dispositions and of the so-called innate ideas. The managers of the world "from behind the screens" know this; for it is the time at which they impose on plebeian women pilgrimages and ecstatic *nervaines*, and keep those of a higher class under more stringent impressions. Here in Vienna, for instance, from the times of the Emperor Charles V till quite recently, when an heir to the throne was expected, the Empress was given in charge of a special director, who would regulate all her actions and surroundings, in view of commencing the course of submissive education of the contingent monarch, as early as the first evolution from the yolk-substance of the human egg, during embryogenesis. Similar influence is now claimed for an object diametrically opposed to the degeneresceence thus arrived at in the house of Hapsburg. It can be attained by advice printed either in book form, or on scrolls, as are the

sentences of the Koran. But whatever may be the form given to this *magna charta* of the rights of the unborn, let it be found precisely where these rights ought to be kept most sacred, in the nursery; where their enforcement would protect the mother and elevate her function, at the same time that it would insure her fruit against the decay resulting from wrong prenatal impressions.

We know that a cold contact with the mother makes the fœtus fly to the antipode of its narrow berth; that a rude shock may destroy it, or originate life-long infirmities; that fear to the mother is terror or fits within; that harsh words vibrate as sensibly in the liquor of the amnion as in the fluid of the labyrinth of the ear. For instance, when a mother has lulled her home-sorrows with strains of soothing music, her child, too often an idiot, shows wonderful musical proclivities floating through the wreck of his mind.

For thirty-five years, the writer has furnished his share of the facts, which abound in modern books on physiology, in support of this doctrine. Here are two more:

1st. Madam R . . . . ., now of Eleventh street, New York, being alone with her sick husband in a country-house, saw, at night, somebody, wrapped in a sheet for a disguise, trying to force an entrance. She, unarmed and unaided, cried out, pushed and piled heavy furniture against the door, and succeeded in repulsing the intruder. She soon after gave birth to a healthy male child, but who, at the hour at which this struggle had taken place, would scream as if in terror. At all other times he was good-humored, but no medical treatment could prevent him from awakening and screaming at that precise hour. This habit disappeared when he was severed from the breast of his mother. Become a man, he has shown endurance and bravery.

2d. When twins come from different sacs, they are often unlike; when from the same sac, they almost invariably resemble each other. As a proof that this resemblance is mainly due to the identity of their prenatal impressions, let us follow this further, as in example of the brothers E . . . . . Born with characteristics almost identical, brought up under the same tuition and habits, in the college St. Louis, they continued to look so much alike, that greeting or punishment would often meet the one instead of the other. One entered the atelier of De Laroche; the other went into some moneyed business. New impressions modified their features; one grew sensitive, the other rich, and their likeness disappeared in a corresponding ratio, until, when seen last, they hardly looked like thirtieth cousins.

Physicians will testify that when our hands receive a newcomer, we read quite plainly upon his features on what sort of feelings he was bred by that intra-uterine education whose imprints trace the channel of future sympathies and abilities. Therefore, if it is noble work to educate or to cure the insane, the idiot, the hemiplegic, the epileptic, and the choreic, how much higher is the work of preventing these degeneracies

in the incipient-being by averting those commotions which storm him in the holy region intended for a terrestrial paradise during the period of evolution! To teach *Him* reverence toward the bearer of his race, to instruct *Her* in the sacredness of bland and serene feelings during the God-like creative process, is educating two generations at once. This is the highest education of the nursery.

From this, the true cradle of mankind, let us look at that made for the baby. There was no end of them in the *pavillon de l'enfant;* and we may find more philosophy in them than the upholsterer intended to put there. Therein the infant will at first but continue his ovum-life; and for this the cradle must be fitted. Let us see. The head is bent, the extremities are drawn up, and the body shaped like a crescent. This attitude gives to the muscles the greatest relaxation, and to the cartilages, which cap the bones, the position most favorable to nutrition and growth. Generally, the baby rests on the right side, to free from pressure and to facilitate the movements of the heart. In this mode of reclining, the left hemi-cerebrum will contain more blood than the right, which is compressed by the pillow. Attitudes concordant with the sleepy habits of the first months, and the activity of the mind during this long sleepiness indicate the future preponderance of the mental operations of the left over the right side of the brain, the approaching superior nutrition and dexterity of the right over the left hand, and even the later causation of more frequent paralysis on the left. For the present, and for some time yet, baby will live mainly in his sleep; during which, more than when awake, he will be seen angry, smiling, or thinking, in the shape of well-defined dreams.

How important it is, then, that the cradle be formed in accordance with these natural indications! A transitory abode between the basin and the bed, a warm, soft, yet supporting recipient, ampler than the former, better defined in its shape than the latter, with curves less short than circles and more varied than ovals. A perfect egg, vertically split, would make two such cradles, or nests, suited either for child or bird.

But as soon as the nursling awakes to the world, and wants to be introduced to everything, his couch must be enlarged and enlivened, and must look more and more like a school and play-room. Otherwise, it becomes a prison, whence, Tantalus-like, he looks at his surroundings. Here is his first lesson of practical sociability. To see and not be able to reach, to perceive images with no possibility of seizing the objects, render him impatient, fretful, or unconcerned, and opens an era of exaction upon others, or of diffidence of himself, or of indifference for any attainment, which unavoidably ends in immorality or incapacity, or in both. Viewed from this stand-point, these cradles, so varied, so elegant, so easy to keep clean, and to carry from the light of the window by day to the recess of the alcove at night—the best being of French

and Austrian manufacture—are yet very imperfect in their bearing on education. Let us mark some of their shortcomings.

Little ones have an instinctive horror of isolation. Whoever studies them knows that, when they awake, they look, not, at first, with staring eyes, but with searching hands; they seek not for sights, but for contacts. This love of contact, whence results the primary education of the most general sense, the touch, is ill-satisfied with the uniformity of the materials at hand, as exemplified at Vienna or Paris. (In November last I saw a similar exhibition, a *Pavillon de l'Enfant*, in the Champs Élysées, but it was no improvement on that of the Prater.)

In this respect, the child of poor people fares better, having the opportunity of amusing himself for hours in experiencing the rude or soft, warm or cold, contacts of his miscellaneous surroundings; whereas the hand of the offspring of the rich finds all around the sameness of smooth tissues, which awake in his mind no curiosity; he calls for some one to amuse him, gets first angry, then indifferent, and does not improve the main and surest sense of knowledge, his touch.

But soon other senses are awakened. Audition—of which hereafter—and vision, for the enjoyment of which the cradle becomes a kind of theater. For a mother must be very destitute or despondent, who does not try to enliven it with some bright things laid on or flapping above. One may benevolently smile at the extravagancies of colors and patterns intended to express this feeling, but he must also give a serious warning.

Physiologically viewed, this is a grave matter. The form of the cradle demands fitness; its ornamentation requires a more extended knowledge. When planning it, a mother must remember that the fixity of the eye upon some object—particularly upon a bright one, and more so if that object is situated upward and sideways from the ordinary range of vision— and through the eye the fixedness of the mind while the body is in a state of repose, constitute a concurrence of conditions eminently favorable to the induction of hypnotism, and its terrible sequels, strabismus and convulsions,—of hypnotism, which, when unsuspected, is not controlled, and often mistaken for natural sleep.

Psychologically viewed, the decoration of the cradle is of equal moment. To surround an infant with highly wrought or colored figures often grotesque, or at least untrue to nature, may, by day, attract more attention than his faculties of perception can safely bestow, hence fatigue of the brain or worse, a resort to the solution presented the early teachers of supernaturalism; but it will, by night, evoke other than the perceptive and rational powers, for when the lights and shadows of dusk alter all the forms and deepen evey color, the faculty of imprinting images being led astray, it photographs distorted imprints, from confused, often moving, sometimes rustling, ornaments. It is then that the perception of the impossible, by the sight and hearing mainly, educates the senses to feed the mind on hallucinations, and prepares it to

believe them instead of inquiring into their causes, till it comes to the fatal *credo quia absurdum*. The seeds of most of the insanities are sown at or before this time.

These were the first impressions that forced themselves upon my mind in the *Pavillon de l'Enfant*. Here is, in a few words, a *résumé* of them: Paucity of the material upon which the inexperienced yet inquisitive baby can exercise, with interest and profit, his sense of touch; profusion, bad taste, and dangerous disposition of the objects which speak to the eye, if not always with the intention, at least with the almost uniform result, of giving wrong or dangerous impressions.

Attention was next called to what had been done, and to what had been left undone, for the cultivation or the satisfaction of the other senses of the infants. But here it was soon perceived that our inquiries went beyond the sphere of what was exhibited. There were plenty of farinas and Rimmel's volatilities, some of Alexander's, Debain's, or Smith's sighing accordeons, but no means of cheering and educating the nascent, yet already inquisitive senses. Further examination showed that the perfumes were there as an attenuation, and the music as a distraction, and both intended for other senses than baby's. From these and other omissions, it was concluded that nursery-arrangements are as yet intended rather for the mother's and nurse's comfort than for baby's improvement. This attractive place was left with another grief.

3. THE CRÈCHE.—This *Pavillon de l'Enfant* ought to contain at least one model *crèche*.

Crèche is the French name of the public nursery where working-women leave their little ones in the morning, and whence they bring them home at night. The *crèche!* Horrid necessity! Beginning of the communistic inclined plane upon which those who pay and do not receive rents slide with a fearful rapidity; yet a kind institution for those already fallen into the gulf. Since, therefore, *crèches* must be, the writer suffered from not seeing their latest improvement represented at the Vienna *Welt-Ausstellung* next to the appliances of the most luxurious nursing. There could have been tested the action of colors, of light, and its various attributes, on the organ of vision; the influence of varied sounds, of harmonies and melodies, on the virgin audition, the mind, and the sympathetic centers; the power of primary perceptions to awaken first ideas, to impel the determinations of the will, and to raise the various passions; the effects of diet upon those passions; the effect of modification of food and digestion; the influence of rest and sleep on the body's temperature, on the pulse and respiration; the influence of the artificial, the moist, or the dry heat of the nursery on the too precocious development of the nervous centers; and, subsequently, on the prevalence of chronic or acute meningitis, diphtheria, and croup; besides many other problems whose solutions depend on the early study of phenomena which can be found in the *crèche* as surely as the flower in the bud. There, better than anywhere else, they may be studied with

profit to all parties. Let us bear in mind that the rich man can never flatter himself that he does a gratuitous charity, since from its poor recipient comes many times its worth in useful experience, directly benefiting the would-be benefactor. We do not overlook the fact that many mothers, particularly among those both educated and fruitful, pay the closest attention to these questions, and become expert therein, but as they lack the means of record and transmission of their observations, their experience dies, so to speak, with each generation. Hence the nursing of babies continues to be a work of devotion, but does not become the co-ordinate and progressive art it ought to be in well-organized *crèches* opened to criticism by public exhibitions. Thus in Vienna, at least, this opportunity was lost.

The child, soon two years old, is up, sees, hears well enough, talks, though imperfectly, walks, though totteringly. Let us follow him where he can yet teach us something, in the *Salle d'Asyle* and in the *Kindergarten.*

CHAPTER II.

THE SALLE D'ASYLE.

MOTHERS AS TEACHERS; THE SALLE D'ASYLE; EFFECT ON THE CHILD; PLAN; CURRICULUM; REMARKS; MOTIVES; DEFINITION.

4. MOTHERS AS TEACHERS.—There are infant-schools of various grades, from the most ragged to the most select; the average occurs in the *Salle d'Asyle* and the *Kindergarten.* Both are intended for the child when he is once on the war-path of curiosity.

But cannot he learn from his mother, instead of going abroad so soon, and while so incapable of self-support, that, off her knees or arm, the physiological heat soon recedes from the surface of his skin? Cannot she teach him as well as rear him, give him the food of the mind and the food of the body, so appropriately comprehended in the word "nurture?" No; at least, few can. Women cannot do it, because they lack time and knowledge. Millions of them have sold their whole lives for a paltry pittance; thousands of others have been taught the basest absurdities instead of the realities which their children thirst for. Hence the children of the most numerous class are compelled to go to the *Salle d'Asyle,* while the richer are sent to the *Kindergarten.*

5. The *Salle d'Asyle,* being open to the needy, receives them younger; the *Kindergarten,* being a pay-school, receives them later. These differences generate in the sequel many other distinctions, the comparison of which will be the more satisfactory for being commenced at the earliest opportunity. Therefore, we would advise the study of the *Asyle* prior to that of the *Garten;* and we would not even counsel making a first visit in the middle or at the end of a scholastic term, when one can only see the order, routine, and monotony resulting from a settled discipline; but rather visit it at the beginning of a session, when the *ancients* (six to seven years old) have left for the primary, and the *freshmen* (two to three) come in totteringly, giving the observer a vivid idea of their first and novel impressions. And how could these impressions be otherwise than novel? New scenery, new language, new rules meet them. The most sensible change, however, comes from the difference in the character of the personal contacts experienced. Only yesterday how frequently did he leave unfinished a piece of mischief, to be kissed and warmed at the contact of mother's larger breast, softer frame and superior heating power? To-day, at the command of a distant index, he is filed among the many, and has to stand by himself as isolated as on the *Colonne Courbet.*

What will he do, then? He will adapt his own mode of association with that of his new fellows, and will thereby give us our first lesson in the art of grouping children according to sociability at different ages.

As soon as the little ones are together, they coalesce in two forms. Seated, they support each other sidewise, not unlike young or feeble birds on the perch at nightfall. Standing, they range in a one-line procession, like the globules of the blood in the act of circulation, or at least as they appear on the field of the microscope. These rudimentary forms of association of the infant, which can also be observed in their first attempts to play, have certainly been taken into account, either instinctively (*con amore*) or philosophically (by the inductive process) in the organization of the *Salles. d'Asyle*. Aside from all theories, it is a fact that the material, the training, and part, at least, of the living motors of the *Asyle* are in accord with the psycho-physiological conditions of the incoming pupils. Here, at least, the school has been made for the child, and the child has not yet been manipulated to fit the school.

Considering the great difficulties attending the building of these *Asyles* where they are most needed, that is to say, where air and room exist only as desiderata, the novelty of the social venture, which looked so much like rearing babies without mother's milk; the liability of falling into the pedagogic routines so deeply rooted elsewhere; and, moreover, the preying of partisans on the asylum, with the view of impressing the innocent with the stamp-mark of their hatreds, are some of the risks encountered, and partly avoided in the creation and management of the *Salles d'Asyle* in most of the European cities.

There was in Vienna no complete model of *Salles d'Asyle*, but several of their accessories, as seats, cards, images, and books, were exhibited. Therefore we deferred forming an opinion on them, till we saw their operation in large places like Brussels and Paris.

We found them arranged with a great similarity of plan. A yard carefully drained and graveled, open to the sun if possible, and planted with trees, discreetly shading its contour; a few shrubs and flowers withal in their season. In the entrance-hall, the children, who come about 9 o'clock, leave their cloaks, caps, and baskets, they wash or are washed, eat, and play, when the weather does not permit them to go into the yard. The *Salle* itself (Italian *Sala*, our school-room, the German *Garten*) is composed of one or two large rooms partly filled with seats and partly open for exercises. The benches are low, long, straight, and movable, or curved, graded, and connected by aisles easy to ascend, or to walk along, in single file. Near by are a few cradles for those who may need to recline. There are two stands to hold the images or tableaux, a chest for safe-keeping of the objects to be used in teaching, and two straw or cane chairs. The rest of the room is level, unincumbered, and ready for the exercises, in which the children make their serpent-like evolutions. The number of children should not exceed fifty, but may reach seventy, a hundred, or even two hundred. Happily, at 12 o'clock they are seated at a meal of soup, and something warm, and, besides, have delicacies from their baskets. This meal, for which the families pay a half-penny, when they can afford it, is prepared by a

servant, who also attends to the wants of the little ones from 9 a. m. to 5 p. m.

During these eight hours, the principal and her apprentice-assistant are continually engaged teaching and training. They have a salary of from $200 to $380. Their duties are to receive and make tidy the incomers, to make them sit, stand up, raise their hands, fold their arms, turn right, left, march softly, or in measure, around the stands, to the graded seats, and then to be seated. Then a prayer is said in dislocated periods by the multitudinous voices, a hymn is sung by the willing ones, standing. They are seated again, questioned on theogony, theology, subordination to the church, and the like, (but not in all the *Asyles* alike;) then off for a well-earned walk, objects, colors, forms, lessons, playing ball, or other game, with accompaniment of selected songs, cantative numeration, the use of the abacus, (*boulier;*) walking again; reading, listening to stories; then a good meal; washing of hands and faces, play in the yard or hall, and repetition of the exercises, till the mother or sister comes to take them home. On this curriculum, and on its various divergent or even opposite tendencies, many observations and long dissertations could be made; few and short must be ours.

If the object was a direct and formal teaching, it would be too comprehensive, as containing too many matters, and as addressed to too many grades of comprehension—from two to seven years—without reckoning idiosyncrasies. Both difficulties might be obviated by separating the lessons, or by separating the ages; but, happily, economy has prevented; so that the *Salle d'Asyle* fashioned itself more after the characters of childhood than upon the set antecedents of other schools; the great teacher was *imitation*, which constantly and silently carries the newcomers in the wake of the old stock.

6. Motives.—This character is particularly noticeable in the way in which children are brought to the front. In other schools, the avowed or principal motive is *duty;* scholars *ought* to work, ought to learn. Here the impulse is *curiosity*, which is awakened only when the child, being ripe for imitation, his teacher has only to touch the proper chord at the proper time, and he will rise and follow in the wake of others. These are the means by which each, in his turn, sooner or later, comes to the front, and begins his active life at his own hour. You see him, at first timidly, raise his little finger to indicate that he, too, will have something to say. If the teacher fails to notice it, the finger timidly returns under the apron, not to show itself again mayhap for months to come. But once out—I mean the mind which rose behind the finger and which will not "down"—he begins to take an interest in the curriculum, and whenever he comprehends, or thinks he comprehends, being in sympathy with the general movement of the school, he will give free expression to his communion in the ideas which agitate the minds of the mass. This observation, moreover, shows that the upraising of each individual mind is not to be exclusively attributed to the teacher's clev-

erness and zeal; but is as much, if not altogether, the result of the action of the synergy of the mass upon the inertia of the individual: the training power of the whole on the unit. Thus there is nothing compulsory, artificial, or unnatural in that double-motive process which helps the child to take his share of the curriculum within the limits of his taste and capacity; these motives are both of the natural order, spontaneous curiosity and simultaneous *entraînement.*

But I am aware that other means of influence, or stimuli, are at work.

The political stimulus is not ashamed to show itself in the *Salle d'Asyle*, there to develop a taste for the ribbons and crosses which have been borne by the French mandarins, apparently not without effect, as talismans against Prussian bullets; but which cannot so well protect children against the pride of trinkets and ambition for meretricious distinctions. And the so-called religious influence, stealthily boring its way into the *Salle d'Asyle*, operates, too, by the action of pagan objects and idolatrous worship; acts on the inexperienced senses, by the teaching of supernatural causes and effects, by the lowering of the natural sciences, and by the falsification of the lessons of history, in order to give young morality an incurable wryness.

These audacities—part of the weapons in the last struggle for empire—are used in almost every school in Europe to degrade the masses, or to keep them in subjection. This would-be-teaching affects various forms. It is partly printed and partly oral; avowed in one school, surreptitious in another; and more explicit before the children alone than when there are visitors. However, now and then one chances to hear the teachers narrate the apparitions of the Virgin Mary; miracles and theurgic cures; the transmigration of a demon into a black cat* for the purpose of carrying away the soul of an infant; the reprimand addressed to a child for having disapproved of the cheat practiced by Jacob on Esau, because that cheat was in accordance with God's designs. Not only are these supernatural and immoral methods of acting on the conscience of infants substituted for the pure and natural motives of childhood, sane curiosity, and good example, but inopportune distinctions of sexes are knowingly intruded, which open the way to unseasonable curiosity.

At first, the Congregationist teachers—in plain French parlance the *ignorantains*, or teachers of ignorance, having once obtained a foothold in the *Salle d'Asyle*, tried to improve it by separating the girls from the boys. That would not work. Separated, they became dull, as if life itself had retired from the *Salle.* Brought together again, girls and boys behaved and learned harmoniously. But what is now, we are often asked, the moral effect of their common attendance? Some teachers say that the girls stimulate the boys by the quickness of their

* The same demon is served up, with flames, &c., to the negroes of Africa; not in *Salles d'Asyle*, but on calicoes provided by religious Europe for their costumes, and for their moral education.

repartees; others that the boys are good examples to the girls by the directness of their answers. Old teachers have noticed that some years the girls had an *entraining* power over the boys; other years the boys were decidedly the leaders. Sexually, there was, thank God, no sex among them. But it was so important to those whose business it is to rule one sex by another that there should be sex, that they determined to create it, where there can be none, among infants. Therefore, they managed to make them feel this distinction, and become, as early as their second year, a prey to the mixture of dread, attraction, mirage, hallucination, and sin, resulting from this untimely revelation. And this revelation was rendered the more offensive by punishing girls by seating them among boys, and boys among girls, where both soon suspect and learn things which require a director of conscience. Henceforward, this power will stand between them and rule them both, even unto death; commencing early to finish late, and low to finish high. To these deleterious influences, the principle which presided at the creation of the *Salle d'Asyle*, and which dictated its successive improvements, has not thus far succumbed. That principle is still, in the main, what it ought to be, the pure love of children, without which none ought to come near them.

He who loves children does not believe them naturally wicked, and he who believes them wicked will, *ipso facto*, make them wicked. If you trust them, they will trust you; be kind, they will be good. But none can love children who have no children, or will have none. That is why, really or potentially, fruitful women love them more than men; and even girls and single men love them more than women barren, whether willingly or otherwise.

It was the good fortune of the *Salle d'Asyle* to be early taken in hand by a woman who could put into its management, with the requisite qualities of the will and of the mind, motherly virtues and powers. Madame Marie Pape-Carpantier stands quite in the same relation to the *Salle d'Asyle* as Froebel does to the *Kindergarten*, which, the former from France, the latter from Germany, they have spread over many countries. At the same time, these infant-schools manifest a tendency to coalesce; and, before their fusion is completed in a more comprehensive plan of general education, it may not be amiss to describe and define their actual characteristics.

The *Salle d'Asyle* is a custodian school where infants are familiarly taught the elements of knowledge and of sociability, with a view to preparing them for the associated labors, which they will have to perform to earn their living.

CHAPTER III.

THE KINDERGARTEN.

DEFINITION; USE OF OBJECTS; HISTORY; TEACHERS; METHODS; AUTOMATISM; TRAINING; THE KINDERGARTEN CARRIED INTO THE SALLE D'ASYLE; IMPORTANCE.

7. Practically, a *Kindergarten* approaches the ideal of a home-like reunion of children, where they are pleasantly placed in contact with nature, and allowed the free expansion of their individual aptitudes and social qualities. This comparatively new teaching was better represented in Vienna than the other infant-schools, for the principal reason that it had more to show. Its show consisted in the objects used in learning and playing—which are there quite identical occupations with the children—and in other objects, products of their own work and play.

Of these objects, the most remarkable are the collections of pictures of animals, objects, familiar human actions or popular scenes, made in view of extending the knowledge, or of provoking speech, comparison, and deduction. The tableaux of animals from Paris (Hachette) are the best; Leipsic furnished the finest graduate scenes. The large tableaux of simple melodies, which can be read from the farther end of an ordinary room, came from Switzerland, where they do not belong exclusively to the *Kindergarten*.

There is also an abundance and variety of typical forms, some used for teaching, others for the construction of complicated figures, and the now unavoidable lettered or colored blocks; also, the sticks or tiles, adjustable with pins and mortises, to represent skeleton-objects, glass beads, (which children will swallow, trample on, and break in dangerous fragments,) ribbons, colored papers and straws, blank books, and sheets cut, marked, or quadrated, to impose their symmetry upon the work done on them; and many other ingenious appliances to please and instruct, too numerous to mention. This richness would create confusion if it were not easy to arrange these objects in their natural order, as those used to impart knowledge and those to exercise the skill. Finally, there are a number of exercises which are not represented in the *Welt-Ausstellung*, but which are detailed in manuals, consisting of movements harmonious to certain tunes, songs accompanied or not by pantomimes, calisthenics, and dancing, not forgetting the practice of the alphabet and first reader, stealthily brought thither by an old teacher, Miss Routine.

However, the *Kindergarten* is a great success. It is well represented at Berlin, Vienna, London, Paris, Brussels, la Hague, New York, and all the other large cities of Europe and America. Moreover, its moral

principle of making the school attractive and learning a pleasure, works its way into the minds of the disciplinarians, and tends to modify the old school coercions and rigors. But as the adoption, in infant and primary schools, of the technical changes introduced in the *Kindergarten*, is only a question of time, this time must be employed in considering what is the principle of this new school, and whether teachers comprehend and apply this principle in its entirety.

8. HISTORY.—For some reason, the history of the *Kindergarten* has never been frankly told; mayhap, because its origin is a reproach, and its success would be a menace, to powerful interests. By going back to its origin, we will better unfold its philosophy. The typical child of the eighteenth century was educated in the first *Kindergarten*. His teacher did not adhere to any particular school, but prepared the natural means of educating all children by a life-long idealization of what homoculture must be. This teacher had but one pupil. The other children of his time were coerced; he was induced. They were still uniformly flogged—each pedagogue holding his ferule, each college boasting of a Brother Frappart, (Strike-Hard;) his child had his natural gifts developed into individual talents and social usefulness. "*Émile*" was the type of modern culture. The history of his progress traced the next curriculum. Free activity became the acknowledged—no more the accursed—motor of youth. The natural gifts were allowed to form the basis of individual talent and of social usefulness; to each man the bent of his genius and a trade.

Who did that? Keen Jean Paul Richter? devoted Pestalozzi? zealous Froebel? No! Jean Jacques Rousseau alone did it!* Pity that such good men are loaded with the honor of inventing what they only peddled! But let us hasten to say that in this peddling of the idea, which makes all men equal before the lessons and impulses of nature, there was, and is yet, enough of glory for all the workers. Why the idea of Rousseau was not as readily applied as it was comprehended by the society of his time—the most quick-witted since the coterie of Pericles—is accounted for by many circumstances. This society was shaken, and about to disappear. The Germans, who took up the idea of Rousseau, were practical teachers, who had even educated deaf-mutes to speak, but by the German method of imitation. This alone must have prevented them from comprehending Rousseau, who had warmly interested himself in the teaching of the deaf-mutes to speak by the physiological method, just then favorably reported by Buffon before the French Academy of the Sciences. From this teaching of J. R. Pereire, and from the experiments Jean Jacques is known to have made himself in educating children, he conceived more practical notions than those of the official teachers of his time, or even of their radical opponents, Locke, Condillac, Helvetius; and was enabled, by his great power of concentration, to work these materials into a structure, whose frame he partly disclosed

* Commeneus and Montague expressed it, Rousseau worked it through.

and partly hid, as does the architect when exposing to view a new monument.

9. METHODS.—The *Kindergärtners* began their revolution by substituting objects for books in teaching, according to the express doctrine of Rousseau; but that is no evidence that they understood his philosophy. For instance, their great and avowed plan in giving object-lessons was to extend the knowledge of the child, not to give more precision and reach to his perceptions. Objects are distinguished by their properties, among which the form is conspicuous. The form results from an *ensemble* of limiting lines, which, so to speak, mold the identity of objects; that is the reason why object-lessons have, for a base, line-lessons. Line-lessons are given by *Kindergärtners* with blocks and sticks, the combinations of which produce diverse forms or figures; but these lessons are not concurrently given in their most ideal realization, which would be by drawing and manual movements. Therefore, the concourse of manual movement with drawing and combination of bodies necessary to perfect ideals remains ignored. The line-lessons, thus limited, may be given in the natural order from the simple to the complex, but they certainly are neither complete, nor systematic, nor productive of serial ideas.

To ascertain if, in the direct teaching of objects, the *Kindergärtners* have been guided by broader views than that of lines, let us consider, for instance, their primary block or figure. Had they chosen it with their senses, as it must speak to the senses of the child, instead of with their mind, they would certainly never have selected the cube, a form in which similarity is everywhere, difference nowhere, a barren type, incapable, by itself, of instigating the child to comparison and action. Had they, on the contrary, from infantile reminiscences, or from more philosophical indications, of which we have no room to write, selected a block of brick-form, or a parallelogram, the child would have soon discovered and made use of the similarity of the straight lines, and of the difference of the three dimensions. By training one pupil with the cube, and another with the parallelogram, one can see the difference.

a. Put a cube on your desk, and let the pupil put one on his; you change the position of yours, he accordingly of his. If you renew these moves till both of you are tired, they will not make any perceptible change in the aspect of the object. The movement has been barren of any modification perceptible to the senses and appreciable to the mind. There has been no lesson, unless you have, by words speaking to the mind, succeeded in making the child comprehend the idea of a cube derived from its intrinsic properties: a body with six equal sides and eight equal angles.

b. Hold a parallelogram, (a pine brick $2 \times 4 \times 8$ inches, if you please,) and give a like one to the pupil. Put it up before you, presenting to view its 4×8 inches face; he does the same. We leave it up, only turn-

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ing to the front its 2×8 inches face, and we continue till we have exhausted all the rectangular positions of our rectangle; every position having given the child a perception of each side, and their reunion in his mind having suscitated a complete idea of the object, and of its possible uses in relation to its form. What a spring of effective movements, of perceptions, and of ideas in this exercise, where analogy and difference, incessantly noted by the touch and the view, challenge the mind to comparison and judgment!

The *Kindergärtner* indiscriminately begins the teaching of forms, either with a cube alone, or with a cube and a ball, or with several cubes, without appearing to suspect the radical differences between exercises of comparison of the different parts of an object, and of two objects, and the exercises of combination of single objects to form a compound one. But the comparison of two objects which are without analogy (like the cube and the ball) is not only incongruous for the child, it is also deceptive for the teacher; the child may distinguish them mainly as playthings, while his teacher may believe he has imparted the notions of straight lines and flat surfaces, and of curve lines and curve surfaces, to his pupil. Having begun wrong, if it is found necessary to use two forms to give birth, by their comparison, to the idea of configuration, then, on one side, let the cube be compared with the parallelogram, and, on the other, the sphere with the ovum. In either of these comparisons, there would be found the elements of a homogeneous judgment, (viz, analogy and difference;) but it would not be a primary one, nor an unmixed one, as seen by the following example: If it was found necessary to use several cubes, in order to produce, by their juxtaposition, the idea of the cubic form, the teacher would soon discover that another idea had crept in among the blocks—the idea of construction, or of the combination of parts to form a whole—an idea which is far from elementary. This immingling of the compound types of lines and forms in the teaching of the elementary ones shows an imperfect understanding of the subject. So does the lack of rational progression in the teaching of compound lines and figures, and more so the noted isolation of these exercises—form-studying, and block-building—from their congeners and factors, drawing and hand-exercises. Every line of the outward world represents a design worked out at the point of contact of pressure with resistance: that is nature's way of modeling its gracious or awful scenery. By a similar process, every line of our own creation is the consolidated track of the passage of our hand; so that every line left behind leaves on matter, and expresses not only an ideal meaning, but the very feelings which agitated it from the recesses of our ideal or sympathetic regions. Whence we conclude that, concurrently to teaching the notions of forms and lines, we must train the hand to execute them—not only as expressions of our ideas, but also of our feelings. Otherwise, we would give an undue predominance to objective over subjective education; and that is what has happened, according to my estimation, in the *Kindergarten*.

10. TRAINING.—Here the hand has been used more and better than in primary schools or colleges; but it has been no more physiologically trained to do the bidding of the will than the mind has to understand the progression of lines and forms.

The objects made by the children, exhibited in Vienna, or seen in the *Gärten*, speak well for the zeal of the teachers and the industry of the pupils; but they are products of the use of the hand, no tests of its training. Some will say that use trains. That is true as far as it goes; and since this has become a part of the problem of education, it is necessary to answer the question, "How far does it go?" No farther than the automatism necessary to repeat a task on a given plan; and it leaves the worker just where, in history, the lower classes in India, in Egypt, and in Europe stopped.

To complete our observations on the unsystematic but practical use of the hand by children, let us incidentally say—though the idea deserves a greater development—that we have at once distinguished two classes of object-making in the *Kindergarten*: one, more play-like, whose history is interesting; the other, more scholastic, whose importance in the method invites discussion.

Object-making for pleasure has probably from time immemorial occupied a large place in the family; but the "Émile" made it almost fashionable. Under the influence of that book, mothers, and particularly fathers, if my infant recollections are correct, brought to this form of unconscious teaching an eagerness equaled only by that of their little ones. We, *petits Bourguignons*, would try to imitate papa's hand, when its moving silhouette on the wall was intended to be a representation of the wolf, the hare, or the carpenter at his bench. We would, after him, build, with dominoes, trembling towers, and, with cards, tents for our soldiers. From paper we manufactured, by simply folding, chicks, (*cocotes*,) houses, Noah's arks, and fleets of less noted historical craft; and with scissors we made purses, scales, hangings, frills, and crowns. We soon learned to cut apricot and cherry stones into hearts, baskets, chaplet-beads; to form the acorn and the horse-chestnut into grotesque shapes, and to make cups and vases out of melon-seeds. The same *Kindergartener* of nature would show us in the spring how to give a voice to the willow, by separating its bark from the wood, cutting vocal cords, and reuniting the parts as a flute; or in summer to pick up tall green rye-stalks, and, under a hawthorn by the way-side, to split them, according to their thicknesses, to produce the varied concert which would frighten the birds on our way home. At home, again, we would be shown the use of tools in our childish undertakings, which, mischievous as most of them would be, unhooping casks to give them more strength, &c.; tearing the covers off our school-books to bind them in a brighter style, could not fail to develop handicraft. But now more of these reminiscences crowd on the mind than we have room for, and we must check their flow, and thank Froebel for having harbored in his *Kindergarten* some of our best vanishing means of home education.

We now come to systematic object-making proper. With blocks, sticks, straws, and the other things, on quadrated tables, slates, or papers, the children superpose objects, inlay ribbons, trace lines, paint figures, and various other things. These pretty combinations they execute, not, as superficial lookers-on imagine, by an intellectual process, but within the strict limits of prepared plans, by the repeating capacity of their motor apparatus, and according to the dualistic operation of their senses, particularly of the vision. On these prepared plans, antipodal arrangements are incited by dualistic sensations, and are performed by the property inherent to muscle of repeating its own vibrations, a property which, in the animal fiber, constitutes automatism. It is this vibratile property—first recognized by Baglivy: *De Fibra Motrica*, cap. ii—which renders epilepsy less curable in proportion to the number of past attacks. It is it, too, which, substituted for the operations of the mind by *accoutumance* in labor, renders them quicker, and more regular at the same time, but insusceptible of perfection in the long run. The effects of both, the dualistic structure and the vibratile property, are well illustrated in the care: *a*, of the infant, who, having experienced on one side of his body a sensation agreeable or otherwise, is left in suspense, awaiting the same sensation on the other side; *b*, and of grown people, who, after rubbing one side of their body or face, or one limb, experience on the opposite side an itching, which also imperiously calls for a similar rubbing. For the same reasons, the kitten makes its toilet very systematically on each side with both paws; and, more to our point, its mother—who keeps her *Kindergarten* at night—when giving it one of her object-lessons with a mouse, or, in default of a mouse, with a paper ball, not only teaches it to see in the dark, and to smell what it cannot see—admirable sensorial gymnastics—but also to catch the game, let go, and seize again, alternately and automatically, with its right and left claws. But from this object-lesson, there are lessons for others than kittens. That is an object-lesson, no doubt, its object being to impart a knowledge of the mouse, of its habits, of its modes of escape and defense; but it is also a subjective lesson, in which the object becomes subordinate to the subject, by bringing forward the training of the senses and of the muscular contractility, necessary to make a living; a result not always attained by human education. But the amount of training which suffices to enable pussy to take its degrees in the instinctive school does not suffice to graduate a child in respect to intellect and moral volition. He is arrived at the point of turning to higher aims. At this point, the *Kindergärtners* fail to establish the link of continuity between the automatic and willed action, the perception and the idea, the instinct and the morality. And why? Because they have employed all the while, knowingly or not, the instruments of the school of the naturalist with the principles of the supernaturalist. Their educational process consisted in assigning to all objects, acts, or ideas, the remotest of the final causes, instead of the nearest proximate or proba-

ble one; or of leaving a blank where experience had not yet given a natural answer.

This culture by the savage-like process of thinking and acting, even in the would-be realistic school, discourages teachers and students, curtails curiosity by rendering its stirrings aimless, lowers the learned into quietism, the ignorant into brutism, and the child to automatism. It is a fact that all matters viewed in that light become dead objects; that men looking in that direction see only fate ahead; and that the nations who, under our very eyes, descend in the scale of manhood, do it just as fast as they place supernaturalism above naturalism in education. In this, the school reflects the condition of science when tainted with the hypothesis of spirit and matter.

This hypothesis, yet supported by the theory of the two lives of Bichat, upholds the idea of an encephalon supreme over the other nervous organs, and receiving its inspirations from powers above, in antagonism to the dictates of Him who rules the parts below. (As a decoy, the investigations tending to locate a *vital knot* in the skull were encouraged.)

The other idea is that of a sympathetic, double chain, acting on, and actuated by, the cerebro-spinal axis and its net-work, the heart and its vessels, the stomach and its dependencies, besides its own many plexuses and ganglia; an idea which represents the nervous system as a unit, a self-acting voltaic pile, good to work as long as the liquids of the tissues remain oxidizable in physiological proportions, without preternatural interference.

Who can fathom the difference which those principles open between two schools? One set of children imposed on by supernatural or miraculous solutions of their inquiries, the other helped to refer phenomena to the nearest natural law already found or to be investigated; one set fated to blind submission, the other free to inquire, and to acquire all possible knowledge. And though it could not be said that the *Salle d'Asyle* and the *Kindergarten* are exact realizations of these typical doctrines—since I have taken some pains to show how they respectively somewhat deviate from them—they are average specimens of the possibility of the adaptation of these doctrines to the present infant-schools, and of the efforts of partisans to put their stamp on blank brains and sympathetic ganglia.

But as these principles are incompatible, and cannot coalesce, there is on foot a plan of fusing the *Salle d'Asyle* in the *Kindergarten*, in view of infusing in the most popular school the progressive elements of the select one. The naturalist teachers are few, and persecuted in several countries; the supernaturalists are organized in corporations, and supported by the powers to whom they bargained to deliver youth shorn of its free will; therefore, the true teacher's task has against it all the external elements, but for it the inward elements of justice and progress.

We watched this movement as closely as possible, and found, naturally enough, the schools of these hunted reformers spreading under difficulties. However, we have seen them, in Brussels and Paris, working well. From the *Asyle*, or *Kindergarten* period, to apprenticeship, the "*Union Scholaire*" carries along both sexes so satisfactorily that its girls and boys have positions secured two years in advance. But in Lyons, where we wished also to see them, those schools had just been closed, a part of a succession of indignities perpetrated by the prefect to raise the anger of the Lyonnais to cannonade them, and, through smoke and blood, to bring Henry V on the the wings of Notre Dame de Fourvière. The good sense of the people defeated this plan, but the *Union Scholaire* was, and still remains, suppressed—for which Notre Dame de Fourvière is yet heard laughing ouright. *Pauvre France!* So that I cannot say that there is in Paris, Vienna, or anywhere else, a true "Physiological Infant-School."

CHAPTER IV.

PHYSIOLOGICAL INFANT-SCHOOL.

ORIGIN AND BASIS; OPPORTUNITIES FOR ITS ESTABLISHMENT; PHYSIOLOGICAL CONSIDERATIONS; SHOULD THE ENCEPHALON BE FIRST TRAINED? CENTRAL NERVOUS SYSTEM; SYMPATHETIC FUNCTIONS; TRAINING OF CONTRACTILITY; AUTOMATISM; RHYTHM; IMITATION; SYMMETRY; ASYMMETRY; EFFECTS ON MAN AND ANIMALS; EQUAL EDUCATION OF BOTH SIDES; RECAPITULATION.

11. The *Physiological Infant-School* will result from the union of the kind training of the *Salle d'Asyle* and the joyous exercises of the *Kindergarten*, with the application of physiology to education. None will question the opportuneness of this intellectual movement; but one may hesitate to predict where it will succeed best. Germany had the start, but failed to comprehend the entirety of the idea, either in general education, when Pestalozzi and Froebel mangled the "Émile," or in special education, when Heinrich *discovered* half of Pereire's "Sensory Education" of the deaf-mute. France, early favored with the ideas of Montaigne, Bayle, Rousseau, Pereire, Itard, and others, has of late shown itself ill-adapted for their culture and propagation, and just now her ruling classes fly into a fury at the simple enunciation of a new idea; conservative Corybantes, they would strangle Hercules in his cradle were he born among them. England has the brains and the means to educate all her men and women; but, just now, she applies both to over-educate gentlemen, from a mistaken comprehension of Darwin's theories. Holland and Switzerland, oases of thought in Europe, would accept the idea of physiological education for infants; but they need it less than other provinces, since their women are the most competent and willing to educate their children at home.

But why look abroad for opportunities which are ripe in our midst? The nation which, in its infancy, organized primary and grammar schools for two millions of children is able to create the infant-school, not by copying European institutions, but by forming its own out of the conception of the popular wants. This new impulse will come as came the former: ideas percolate through minds, like water through the soft rind of earth to form mighty currents; let us only tell the truth, it will soon be realized; fifty thousand lady teachers, who listen for the approaching idea, stand ready to apply it if true,

12. PHYSIOLOGICAL CONSIDERATIONS.—Of the three factors of the Infant-School, we have sketched the *Salle d'Asyle* and the *Kindergarten*. We must now sum up the contributions of physiology to the natural method of education. The physiological method trains the organs to educate their functions, and, conversely, exercises the functions to

develop their organs. But whatever may be the gross proximate organs of our functions, these organs are subordinate to the nervous system; all actions being initiated or reflected by, or conveyed to, one of the nervous centers by nerve-cords. Electric currents likewise occur in animal muscles and in vegetable tissues; but the stimulation of animal tissues takes place in the hundredth part of a second, and that of the vegetable tissue in about a third part of a second. After several strong stimulations, the fiber of a frog loses its contractility, but recovers it after a rest; so, after each stimulation, a leaf is, as it were, exhausted, and requires a rest of ten to thirty seconds to recover its contractile capacity. Thus the process of vital contractility is the same in the vegetable as in the animal tissue, only thirty times slower to recover itself after exhaustion. But what amount of scholastic stimulation can a child bear? And, when he is exhausted, how much of rest is needed to restore his nervous contractility? Who cares? In other words, the modes of expenditure and of restoration of contractile synergy, which is the first function of all living organism, are not, but should be, studied in the child, as they have been in the frog, or in the *Diæcia*, by Dr. J. B. Sanderson; so that this calculation could be made from the beginning the economical basis of education.

The economical basis of education rests upon the facts that every being has his normal heat; that man has his—98°.6 Fahrenheit, or 37° centigrade—0 of the Physiological Thermometer; that any deviation from this *norme* represents an abnormal oxidation; and that, by the vibration of the nervous apparatus during afferent, reflex, or deferent circuits, surplus heat is evolved. This surplus heat evolved at school above the *norme* (98°.6 F.=37° C.=0 of the Physiological Thermometer) represents the economical expense of life in labor, as the surplus heat evolved during fever is the mathematical expression of its waste in disease. But how a scholastic expense of heat of .4 C. above the *norme*, from morning till night, may suddenly or gradually increase to one, two, or more degrees, and become, not only pathological, *but deadly*, is the first problem which raises itself, like a specter, before a teacher who has thus lost some of his best pupils—unless he purposely educates them for the next world.

A well-manufactured but sophistic book recently created a sensation by attributing to overwork at school the ruin of girls' health. If the author had looked his subject ("Sex in Education") full in the face, instead of in the tormented profile of enervated young ladies, he could have seen that the collegiate curriculum is as murderous for boys as for girls when applied by learned ignoramuses. For instance, in a single family, history records two of these victims for 1872-'73. The young Duc de Guise, and Don Fernando de Montpensier, his cousin, who both died from scholar's meningitis, which could have been suspected, watched, and arrested upon the timely indications of physiological thermometry; an art advocated by Littré, therefore neglected by the governor of these princes, the archbishop of Orleans. But there are thousands of over-

worked brains—irrespective of sexes—which, not being of royal pulp, leave no names—heads on wings floating in the tears of their mothers. Therefore, before commencing their course, teachers must establish the individual *norme* of temperature, pulse, and respiration of each pupil, unless the latter comes from home with these *normes* already established —*normes* far more important than the proofs of vaccination. And they ought to refer to this standard of health, if not daily, at least whenever the child seems overworked.

13. TRAINING.—And now for the work of the school. What training will best please, suit, and benefit the infant? That which corresponds to the organization and to the natural evolution of the functions in childhood.

This order does not tally with the trilogy of mind, soul, and matter; nor with the dissection of the mind in mental faculties; nor with the monarchical pretensions of the conjugal couple of cerebral hemispheres over the whole nervous system; but it harmonizes with the observations of Vic D'Azyr, Cabanis, Durand de Gros, Brown-Séquard, Vulpian, and Shiff, who have gradually disclosed the capacity of small ganglia and even of the peripheric termini of nerves to become the starting or the central points of aneurotic action, in which the encephalon may act a secondary or no part.

Ages before the brain effloresced in convolutions in mankind, living things had appetences, emotions, sympathies, or repulsions, and biological duties, not unlike those which to-day challenge our admiration in fishes and insects. In our species, fœtuses have been born living without brain or spinal cord, like the lower animals, destitute of these organs. But normally, when the rudimentary encephalon is not yet in contact with the world through the senses, the sympathetic current makes the fœtus participant to the effective and affective modalities of the mother, through the umbilical cord. Through this conductor of impressions, circulation, nutrition, neurility, are altered or strengthened; infirmities and deformities, superior or strange endowments, are acquired; moral individuality is even formed *in utero* as in a mold; all this while the head sometimes receives, but never gives, the impulse. When the child is yet attached to the mother by the mammæ, everything coming to his senses, and mostly to his tact by contact with her, is intuitively known and resented, without the slightest interference of the mind, through sympathies.

At the time he enters the infant-school, if the child has not been brutified by an intellectual education, and his anatomical plan tortured by forcing his impressions toward the brain, one can see in him, as in a mirror, the anatomical bent of his impulses or of his impressions. The sympathetic appears as a tramway of both sensitiveness and conduction, leading to and from all the viscera, and also as a generator of nerve-force ready for distribution, to the head by the cephalic filaments, to the heart by the penetration in it of small ganglia, to the stomach by

the solar plexus, to the intestines by the mesenteric, asserting over all its initial or inhibitory, always moderating and central, influence. When this view shall have received the attention of true teachers, they will alter their curriculum in this wise—will cease to exclusively cultivate the upper portion of the nervous system, and will bestow a proportionate attention to the wants of the more central ganglia, and train the functions of the whole system in view of their co-relations and concordance. Then will cease to rule, rage, and ruin the inner dualism which, instead of being created by Satan, created him. Then teachers will be able to return service for service to physiologists, by demonstrating that the cause of the increase of insanity, of almost all the insanities, is the discordance, nay, the antagonism, raised by education, customs, and creeds between the cephalic and the central parts of the nervous circuit; that the functions disorganized, at first are curable at once, but the organ subsequently altered by *accoutumance* or shock is rendered incurable. This we predict, and support on the evidence that, in true savage-life, where the whole nervous system is evenly let alone to the drifts of instincts, insanity is unknown; but where the strain on the mind is excessive, and the sympathetic wants ignored or subdued, insanity is rife. So it is with the Polytechnic School of Paris, which produces possibly the best scholars, certainly more insanity than any other French school.

Unfortunately, it is yet popular, and may remain so for some time, to extol, and, alas! to excite what is called the intelligence of infants. But if an infant was allowed to grow by his physiological and only safe growth, it would be seen that cerebral activity does not play the conspicuous part we are inclined to think it does in his determinations; that what we mistake for his judgments are his sympathies; that we cannot without peril rashly fill his brain with impressions which may, or may not, in after years, become the elements of mental operations; that, unless these impressions are directed toward the sympathetic organs, they have no action on the eventful feats of childhood, and almost none on those of later life; this for many reasons, of which two will suffice.

a. At this age, external impressions may be reflected on the cerebral convolutions, and on the sympathetic central ganglia, as images of objects are reflected on surfaces sensitive to light. But there is this difference: when the impressions on the gray matter of the cerebral convolutions have become mixed or defaced, they leave no trace; but when the impressions have vanished from the sympathetic ganglia, they yet leave behind such indelible determinations as will overrule the intellectual teaching. Supernaturalists penetrate this way to take their mortgage on the coming man; if they can pervert this sense, upright educators ought to be able to train it in the right direction.

b. Another difference is in the process of entrance of the perceptions toward the cerebrum or the sympathetic. If the object to be per-

ceived by an infant is directed toward his reflective centers, his effort at thinking is almost always too great for the object, and, grayhound-like, he overleaps what you wanted him to grasp; or, if he comprehends and appprehends it right, it is by a concentration of synergy, for which an abnormal amount of blood is accumulated in the encephalon; the congestion is announced by the color and swelling of the blood-vessels, and the effort by a rise of the surface-thermometer at the temples. If, on the contrary, the objects presented to his perception have been directed toward the affective nerve-center, their impressions are more sure and do not predispose, like the former, to infantile hemiplegia or meningitis; he feels them like a sensation about the diaphragm, during which the respiration may be somewhat momentarily suspended by the emotion, then resumed deeper, with a quicker beat of the heart and a blood-current of an inexpressible happiness. Who has not kept, at least, a vague remembrance of this state of our infant bosom when it was permitted to saturate itself; without admixture of forcing reasons and reasoning, with the emotions produced by new contacts, new movements, new colors, new sounds, new voices, new associations, new sceneries, new people; for instance, the features of a new baby in the family, all things which, touching us to the quick, touched us forever. But how few children are allowed the inenarrable delicacies of this education by the sympathies! Some given up to pedantic mentors; some crushed by home tyranny; some nursed with depressing mythologies; some anæsthetized of noble feelings by debasing wants; most of them rebuked for their silly eagerness to know things which they can find out for themselves as soon as they have mastered the twenty-six symbols, which are supposed to contain all knowledge, and therefore they are hurried to the book. And how few remain, stray babies, on the laps of placid mothers, allowed to feel their own surroundings, and to come out from this emotional baptism, poets, painters, *savants*, interpreters in their own language of mother-nature! Agassiz began one of his most renowned courses by begging each of his pupils to come to the opening lesson with a grasshopper in his hand. Why could we not begin lower with infants by encouraging them to come to school with the things in their hands which please them best?

c. What we have said of the collective movements of the infants in the *Salle d'Asyle;* of the power of automatism on the production and repetition of movements; of the aptitude to imitate, which carries one child after another into the vortex of the movements of the school; of the organic dualism of our senses, by which are supplied the elements, and acquired the habits, of comparison; of the differential impressions made by the sensations, according as they are directed toward the sympathetic or toward the encephalon; of the local congestions, and of the evolution of heat as a result of oxidation during scholastic labor: these elements, though unavoidably scattered here, can easily be united in the mind of the reader to form what they really are—the broad physiological basis of infantile education.

Commencing by the exercise of muscular contractility, we must make good use of the sympathetic adhesion of the infant to his mother. The transference of this propensity toward his mates we have witnessed in the *Salle d'Asyle*. Add to this his automatic aptitudes to repeat a movement once made, to support these repetitions on rhythms, and to be impelled by imitation, and you have a perfect living realization of what seems impossible in the abstract—an individual without individuality, only with latent sympathies, that is the infant; and these are the means of training his first steps out of impotent dependence. To develop his individuality, and to gradually sever him from outward supports and dependence, you have first to use these supports and connections, so as to be able to drop them gradually, and to leave the child self-supporting enough to select his own independent associations. Such appears to be the stadium of muscular contractility through which he must pass, from automatism and imitation, to rational and willed activity.

d. The opening exercises of the infant-school would correspond to these first physiological indications. In them, the children at first adhere to each other, move in cadence, automatically, then in imitation, all together, with little attention, and an almost indifferent pleasure, in which the brain has no part; a kind of quiet and sympathetic lullaby, not unlike that which induces hypnotism, leads their movements, which gradually attain to natural, healthy, precise, and independent attitudes. Their progression toward the complete mastery of their contractility would run thus:

The establishment, in well-defined series, of these grades, from automatic to reasoned and willed exercises; from general to special movements; from personal acts (acts relating to the child) to objective acts, (relating to objects,) &c.

The grouping of children, according to some anomaly in *plus* and *minus* of their contractile functions, or to imperfections in their organs of contractility, to correct which it is generally sufficient to institute special trainings. (It is thus that the anomaly—rather, a disease, chorea, which always affects one side more than the other—is almost invariably prevented, or recedes before an appropriate muscular training.)

The gradual bringing of all the available forces of contractility under the control of the will; at first in individuals, later in groups, and by exercises more and more complicated.

The gradual concentration of automatic, imitative, and willed exercises of contractility in the hand, in order to render it capable of executing with the utmost rapidity and precision the orders from the encephalon.

The elementary training of both sides of the body, and of both hands in particular, in order to ascertain how far the two sides can be trusted with advantage and without danger, to work either alternately, substitutively, complementarily, or concurrently.

(We have pointed out the importance of this last problem at birth, and, further on, will have to refer to it in connection with professional education; but here, at the start, it is particularly desirable that teachers should know that the anatomists and physiologists have brought the question to the door of the school, therein to receive its most practical solution.)

A little attention to this problem discovers in it two factors, primary organism and education. The effect of the latter is continued by *accoutumance*, whose life-long and hereditary operation modifies the former.

14. SYMMETRY IN TRAINING.—About organism: As circulation supplies the material for action, we must first consider the differences in the canalization of the arterial blood at its issue from the cross of the aorta in man and in animals, in order to find the exact position we occupy in regard to our modes of activity. In this respect, I have stated that infants generally lie on their right sides. This reclination, which is a primordial sequence of anatomical structure, soon becomes, in its turn, a cause of exaggeration of the structural inequality. In mammalia, the blood, gushing from the heart through the cross of the aorta, finds its way up by different systems of emergences. When the emergence of the cephalic arteries from the cross of the aorta is unique, and its upward canalization perfectly symmetrical in its right and left bifurcations, as in the horse, the movements are swift and harmonious, the temper may easily become bewildered, but the animal will fight well only for love and in self-defense. The same unique emergence, but with less concording bifurcations, produces the equally swift but less symmetrical movements of the camel and its tribe.

When the emergences from the aorta are two, lateral, equidistant from the apex of the cross, and when they send out symmetrical branches toward the fore limbs, the animal makes harmonious movements and is ambidexter, as the porpoise, the mole.

When the emergences are again two, the left brachial unique and small, the right trifurcated for the brachial and for the two cephalic arteries, there are bouncing movements and war-instincts, as in the lion, the bear, the dog. A similar irregularity, with the cephalic arteries emerging nearer to the aorta, belongs to the wild boar.

When the emergences are three, a central and a left one small, and the right one very large and quadrifurcated, there is a mixture of celerity and ferocity, as in the cat and some dogs; or an awkwardness in celerity, as in the giraffe and kangaroo.

When the emergences are three, one right and one left for the brachial arteries, and a main cephalic regularly bifurcated, as in the elephant, the movements are harmonious, and the organ of prehension and dexterity is central and unique; the proboscis is the hand. The same vascular apparatus, to which is added another horizontal bifurcation of the cephalic trunk, belongs to the more unruly rhinoceros.

In man, as in the castor and chimpanzee, the emergences from the

aorta are also three; but in reality the right one, the largest, soon bifurcates to form the subclavian and the carotid of this side, and to reestablish a sort of symmetry between the systems of arterialization of both sides. Thus, in man, the canalization of the arterial blood toward the head appears as a composite of the various systems of circulation of the mammalia; not so symmetric as in the horse and elephant; not so asymmetric as in the wild boar or kangaroo, but yet irregular enough in the hematose of his two sides to make him one-sided (generally right-handed) in his movements, and sometimes more ferocious than is consistent with his pretensions to Christianity and philanthropy. It would result from this anatomical survey that the more asymmetric is the hematose, the more irregular will be the movements and the more bloody the instincts.

What will physiologists tell us in their turn? They present a more hopeful view of the case by demonstrating the action of education and of *accoutumance*, not only on the hematose, but through the modified hematose, on the very form of the vessels through which it runs, and *vice versa*. The economists have proclaimed the half of a great truth when they said, "The supply creates the demand." Physiologists may claim to have discovered the other half of this aphorism when we said, "The demand creates the supply." Thus completed, this whole truth will rule the reciprocal husbanding and economy of circulation and activity. Now, a greater supply of blood to the left hemisphere incites this hemisphere to more brain-work, and the right side of the body to more muscular work; but let the training of the left side of the body call for more blood, and the right hemisphere will soon receive more blood and be better able to assist or supplement the left in brain-work. This is no hypothesis, but fact, since, in naturally left-handed persons, the arteries of the right side of the head, and those of the left side of the body, have been found to contain more blood than their opposite; and in proof that not only the quantity of the hematose is affected, but also the form of the vessels, by certain modes of activity, there are thousands of pathological specimens showing deformations of vessels produced in a very few years by the repetition of a movement, or by the constancy of a vicious attitude.

15. Application to education.—From these facts, the following conclusions are forced upon us:

1st. The evidence that no system in our organism is so amenable as the circulatory system to primary diversity of structure and to secondary modifications, anomalies, even to anatomical monstrosities, traceable to protracted exertions or attitudes.

2d. The inference that no other system of our organism is more modifiable by an early and well-planned training, and that, if man can be rendered more serviceable as a worker, more harmonious in his movements, more delicate and thorough in his perceptions, and more kind and amiable in his family and social relations, it will, to a great extent,

be through that part of physiological education which tends to equalize, on both sides our hematose, the oxidation of the tissues and the evolution of heat by *ustion*, from the Latin *urere*, to burn, complemented in *combustion*. (See the Manuals of Clinical Thermometry.)

Therefore we cannot begin too early that equal education of both sides of the body, which, to make an impression, must also become an *accoutumance*.

The tendency (already noted) of the new-born to lie on the right side must be prudently corrected; he has likewise to be carried in turns on the right and left arm; and when he makes his first steps, he must be held by both hands alternately. Then come the dualist exercises of the senses, which may begin by the tact, since children dearly love to feel themselves touched and tickled on both sides. The exercises of alternately hearing and listening with each ear come at the same times; so those of changing the position of the child in relation to light, now to the left, then to the right, also horizontally to, or higher or lower than its angle of incidence; both hands particularly must be impartially educated to take hold and let go, to move at will or at command each articulation, exercises which differ from those to be farther described only by their special reference to ambidexterity. By these means may be restored to our race an inexpensive power, more permanent than steam, and equally applicable to mental and physical labor; a power which, in many cases, can double the products, and which in all cases can save or economize the ordinary one-sided powers. By this restitution to our children of this natural capacity, many diseases and infirmities will become unknown or rare. For instance, the right hand would never become afflicted with the telegrapher's, seamstress's, or writer's palsy if the left hand could hold the needle or the pen when the right hand is tired. Another consequence of the restoration of activity to the left side of the body would be an increased activity in the circulation and functions of the right hemisphere. This would induce equal or substitutive mental operations from both hemispheres, by which more continuous learning and thinking could be accomplished; and the fatal consequences of excessive strain on the brain, hemorrhagy, embolism, and ramollissement would remain senile accidents instead of becoming the ironic rewards of young heroic efforts. And, moreover, by this even education of the two side-organs, and by the more equal hematose of the two side-circulations which would follow, the human temper and passions would be harmonized and subdued to a point which the mind cannot reach to-day, but whose social consequences cannot be overestimated.

This is the part of the work to which anatomists and physiologists invite the teachers. Not to repeat here my own appeal, it seems but yesterday that the lamented Agassiz urged his pupils of Penikeese Island to become ambidextrous if they wanted to become good naturalists; and that my illustrious friend Brown-Séquard proclaimed at his

Lowell course of lectures the equal training of both sides in our children as an urgent necessity. (Since this was written, he delivered another lecture expressly on this subject at the Smithsonian Institution. No student of human nature can afford to ignore this beautiful *conceps* of his: *Have we two brains?*)

This training, contrary to habits, tradition, and heredity, must begin almost with life itself; if not in the cradle, in the infant-school at the latest. But to undertake it, it is necessary to understand the place it occupies in the general plan of physiological education; there is a place for it in the series we have just surveyed, and prior to that, as we will presently show.

The education of the muscular system is founded upon the nerve property to contract muscles; of contractions to repeat themselves; of repetitions to be amenable to rhythms; of rhythms to incite imitation; of imitation to provoke like movements in other people, or in the other side of the same body: a whole series of functions, contractility, automatism, imitation, dualistic symmetry, which have to be developed to the rank of working capacities.

Let us add to this the elements of the education of the senses; the training of the faculty of speech; that of the art of receiving, storing, and expressing impressions, which is the natural gift of infants; and we will not need books to fill up the emptiness of our teaching till the child is seven years old.

CHAPTER V.

OF THE SENSES.

SEAT OF SENSATION; TRAINING OF SPECIAL SENSES; NATURE OF IMPRESSIONS; TEACHING WITH PLAY-THINGS; OBJECT-LESSONS; TRAINING THROUGH PHYSIOLOGICAL CULTIVATION.

16. OF SENSATION.—The training of the special senses rests, *ex æquo* with that of contractility, at the threshold of the infant-school.

It should be said that a large place was given to it in the section of education at Vienna; but it would give support to the dangerous opinion that "to educate through the senses" is the same thing as "to educate the senses themselves." For though it cannot be denied that by the former process the senses are indirectly more or less improved, it is true, nevertheless, that they will hardly ever receive from it the accomplished powers of perception, and of transference of images to the sensorium, which would accrue from a gradual and truly physiological training. If we needed a proof that the education of the senses has never been done—except by J. R. Pereire, for the special sense of hearing in the deaf-mutes; by Itard, for the savage boy found in the forests of the Aveyron; and by some more recent teachers of idiots—unless empirically through object-lessons and automatic exercises, we would find this, proof in the *Welt-Ausstellung*, where there were so many means by which the sense of sight could be improved, and not a single one to be applied to the training of the sense of touch. This reservation being made, we acknowledge the quantity, variety, and value of the objects gathered to please and instruct children, and to employ their activity by some hand-work or play. These objects could not be arranged, for the reason assigned above, in any order corresponding to each sense, nor to the ideal they satisfy in the child, as wonder, curiosity, imagination, and causality; but they were separated as school-appliances and play-things, (*joujoux;*) and also by nationalities, the latter category offering occasion for curious remarks. Before indulging in some of them, let us signalize a fact which dominates all others in the use of objects for educational purposes.

When sensations penetrate through the peripheric nerves, they are directed sometimes by a self-impulse, and oftener by an external one, as a teacher, toward the sympathetic, or toward the brain; and though these directions cannot be said to be absolutely exclusive one from the other, they may be rendered so prevalent that it is physiologically true that in one case they are felt, and in the other analyzed. At this point of recipience of impressions, it is of the utmost importance, in order not to commit an irreparable mistake, to understand well the nature of the impressions

to be made, and the psycho-physiological aptitude of a child to receive them. In regard to the nature of the impressions, some phenomena are better appreciated by our sensitiveness and others by our judgment. A child, misled in this, will hardly ever be able to retrace his steps in the right path, particularly if he has been directed to reason what he ought to feel. In regard to the aptitudes of the child, his capacity for receiving sympathetic impressions is anterior to that for forming rational judgments; and if he is provoked to reason his impressions before he has been allowed to be sympathetically moved by them, his emotional apparel will be retrenched from the circulation of impressions; and what may appear later as his own feelings will be others', implanted in his head, as he himself would plant cut flowers in sand and call the collection his garden.

17. OBJECT-LESSONS.—If these remarks help us to comprehend how playthings act in education, let us now speak of jôujoux.

At first sight, such a vast array of playthings as was spread on the Prater left the impression of silly sameness. A second look discovered in them particular characters, as of national idiosyncrasies; and a closer examination showed that these puerilities had sense enough in them, not only to disclose the movements of the mind, but to predict what is to follow.

The Chinese and Japanese toys are innumerable, as was to have been expected. They have in common a mingling with real life, and appear, at least to the writer—a barbarian—profoundly mortised into the system of education of both peoples; so much so, that it seems impossible—for the same barbarian—to establish a line of demarkation between their playthings and their object-lessons, and particularly between the images made to cultivate humor, to excite interest, to spread ideas and criticisms, to educate directly by the illustrations, or indirectly through the accompanying text; the whole forming a solid bulk of toys, preying on the mind, when pleasing the senses. In other respects, their toys are more unlike than we were prepared to find them. Taken in a block, how much brighter are the Japanese toys! Relieved in gold and the gaudy colors of the Breughels, their dolls, single, oftener grouped, are absolutely saucy, rollicking as on a spree of good humor and haughtiness; but how much more sober in colors, meek in demeanor, and comprehensive in mien are the Chinese, who look so wise, and are willing to tell you all that their personal experience of sublunary troubles has taught them! We have not seen, in the Chinese toys, these incitations to an awakening of curiosity for natural phenomena which characterize the Japanese. In this latter, the application of the natural and mechanical forces to produce a striking effect upon the imagination of children cannot fail to determine the taste of the next generation toward physical sciences. Meanwhile, the Chinese' favorite joujoux remain theatrical scenes, where the family is treated *à la Molière*. If toys mean anything, these tell us that Peking is the Paris, and Yokohama will soon be the London, of the East.

For fear that we may not find a more appropriate place, we will here confess a predilection for the material art of these eastern people in manufacturing playthings. First, their play-books are of a paper whose tint does not offend the eye of children, and whose toughness resists ill-usage; in book-form, but without stiffness; or in scroll-form, like the Jewish, they can be roughly handled among ruder playthings. Next, we profess a true enthusiasm for the beauty, adherence, and softness of the colors and varnish employed in their book-toys, object-toys, animal-toys, human-toys, godly-toys; and appreciate the more the fastness of their paint, when remembering to have in our infancy seen a brother sister, and self tattooed with the colors of dolly; or older, to have attended to children sick or dying from the ingestion of the poisonous pigments of toys.

Persia, too, sent beautiful joujoux, from which can be inferred a national taste for music, since most of their dolls are blowing in some instruments. They stand in groups, like our itinerant German performers, but, unlike these latter, gorgeously dressed.

Turkey, Egypt, Arabia, have sent no dolls. Do they make none, under the impression, correct in a low state of culture, that dolls for children become idols for men? But Finlanders and Laplanders, who are not troubled with such religious prejudices, give rosy cheeks and bodies as fat as seals to the dolls which teach their children how happy and healthy one may be in a paradise of ice.

So, from childhood, every people has its sympathies expressed or suppressed, and deeper in its flesh and blood than scholastic ideas.

To make short a long story—for what a pretty and philosophical book could be written on toys alone—let us see those brought to the Danube from both sides of the Rhine.

The French toy represents the versatility of the nation, touching every topic, grave or grotesque, intentional agent of sympathetic education. Paris was once the arsenal of infantile arms and armors; now from Berlin come the long trains of artillery, regiments of lead, horse and foot, on moving tramways; but from the Hartz and the Alps still issue these wooden herds, more characteristic of the feelings of their makers than of the instincts of the animals they are intended for. France, no less true to her old love, has made dolls for the western world since Henry IV brought them from Florence with their persecuted and famished makers. But will she keep even that superiority with rulers who say they have not yet killed workmen enough—must make another *saignée*, &c.? Her doll-makers were the initiators of fashion for the world. If they are killed or scattered, where will the genius of taste in handicraft settle?

This art of the artisan, *ars vulgaris*, possibly, not certainly inferior to, but more extensive than, the *beaux-arts*, is taught from the cradle, with toys at first, and by graduations commensurate to the genius of childhood. The children who have no toys seize realities very late, and never

form ideals. The nations rendered famous by their artists, artisans, and idealists have supplied their infants with many toys; and as there is more philosophy and poetry in a single doll than in thousands of not despised books, let us see how this despised thing, a doll, a toy, a *joujou*, acts so important a part in human destinies.

Toys are intermediate means of experience between the great realities of life and the littleness of the child. Things in general are so disproportionate to his stature, so far from his organs of prehension, so much above his horizontal line of vision, so much ampler than his immediate surroundings, that there is, between him and all these, a gap to be filled only by a microcosm of playthings, which give him his first object-lessons. In proof of which let him see a lady richly dressed, he hardly notices her; let him see a doll in similar attire, he will be ravished with ecstasy. As if to show that it was the disproportion of the sizes which unfitted him to notice the lady, the larger he grows the bigger he wants his toys, till, when he reaches to life-sizes, good-by to the trumpery, and onward with realities. But before he reached this point, toys did him good service. We mean if they were offered with due regard to his development; if they were not at the outset prematurely used to educate the senses; and if the natural play of the child's emotional impressions had not been interfered with by pedagogic reasonings. If these, and other like blunders of eagerness, blended with stupidity, have been avoided by the toy-givers, the infant will have received from his toys these affective emotions of pleasure or pain, of harmony or discordance, of love or antipathy, which will characterize, as a baptism, his awakening moral self.

And to obtain this incalculable boon, what is needed? Let him alone with his toys, and watch, and guess, if you can, by what inroads and outroads the communion between the doll and the child is accomplished. The fullness of heart and thankfulness for a bright present make room for the calmer sense of ownership which a child identifies with manual possession. He does not understand the *idea* of property, but *feels* it in his grasp; he never experienced this feeling about his garments, but the universe of children would like his toys, they cannot have them, he grows serious. Once his possession assured, the child endows it with all the qualities of an ideal, and devotes himself to it as to a reality. True to this sympathetic conception—though his mind knows it to be false—he, who never before looked into the future, opens this blank book of human imagination, and writes on it all sorts of contingencies, of which the toy is the magic spring and center; if a dog, they go hunting together; a cottage, it is filled with playmates; a cart, it is made to run; a horse, to ride on; a hen, to lay eggs; paper flowers, to blossom; wax fruit, to ripen; dolly won't learn, is punished, gets sick, dies, has impressive funerals, &c. Softened by the diversity and sincerity of these emotions, the child relaxes his grasp, and consents, for love, to let a brother play with his things; the door of generosity is

ajar, an opportune example of your own liberality, without ostentation, will throw it wide open. Thus, this world of toys suscitates in the child a corresponding world of emotions and a cyclopedia of ideas. Take away the doll, you erase from the heart and head feelings, images, poetry, aspirations, experiences, ready for application to real life. The Egyptians would not suffer the dead to retire forever without their dolls. But soon, for our child, the plaything deteriorates, or, compared to newer ones, loses its prestige; is looked upon coldly, then skeptically. What is it after all? To form it, how do the pieces hold together? And how is he to know but by taking them apart? Away they go. The mystery is solved, but the poetry of the toy is gone.

Now for the reality. Having learned by the destruction of his toy that things are made of parts, he is ready to distinguish in objects their parts and properties, and to take systematic object-lessons. Here the teacher must bear in mind that cramming with objects is as bad as with books. Before making some remarks on these lessons, this disquisition on toys must be excused upon the plea that they speak to the feelings when the mind is not yet open to reason; that books cannot teach what toys inculcate; that the nations who had the most toys had, too, more individuality, idealism, and heroism; and that if you tell what your children play with, we can tell you what sort of women and men they will be. Then let us have toys, instead of books, in the Physiological Infant-School; and let this Republic soon make the toys which will raise the moral and artistic character of her children, as much as the toys of the South Americans have lowered their race by the substantiation of base and bloody instincts. This is not all we have to say about toys, dolls, images; but the rest will come more appropriately in another part. If we have helped to restore to playthings their place in education—a place which assigns them the principal part in the development of human sympathies—we can now put in the hands of children the objects whose impressions will reach their minds more particularly.

In the Infant-School, object-lessons will present themselves under two aspects: that of studying, and that of making objects.

To study objects is to observe their arrangement and their properties, as form, color, odor, movement; to learn their actual usage; and to infer their possible applications.

To make an object is to select the parts, or attributes, which enter in it; to put them in due *rapport*, and the whole in suitable order.

One of these lessons complements the other; they represent the Janus-aspect of our knowledge; nothing is thoroughly known if not learned by that double process; but double does not mean confounded. The *Kindergartener* mixes them up; the physiological teacher will keep them distinct; the more so, when he needs to use them by apposition. The former makes confusion because his aim is only to give object-lessons; but the latter cannot fall into the same confusion, since he uses objects only incidentally, to develop, now one function, now another;

primarily aiming at personal development, secondarily at knowledge. In the physiological school, the *observation* of objects will particularly be subservient to the training of the senses, and the *making* of objects will mainly be regulated by the wants of the hand to execute, and of the mind to conceive ideals; therefore confusion becomes impossible. Such is, at this point, the programme of the infant physiological school. It embraces the direct and special training of each sense, and the reflex training of the mind, and of the creative activity through the senses. To unfold this curriculum, we shall be obliged sometimes to sacrifice the unity of its plan to the multiplicity of the details to be brought into relief. At other times we may not be able to forcibly mark, in their places, the mental connections of the plan; for, as man is a unit, every part of him, or function of his, which we consider separately, by a *modus loquendi*, is intimately connected with all the others by the *modus vivendi*, and the reader has to reunite what the writer has to dissect. In the present juncture, for instance, he will have to connect what has been said of the sympathetic—not as a regulator of nervous action between the viscera, but as a center of impressions as far back as the fœtal period—with what he will have to say of the education of the senses. Another necessity of the subject will be that, after explaining the elements of the education of the senses, and their bearing on the functions of the mind and of useful contractility, which properly belong to the infant-school, the force of the idea may oblige him to carry it into the primary, and sometimes into the higher and professional schools in order to demonstrate now, from the cultivation of the roots—ganglia of the sensory nerves—branch, in all directions, skill and creative genius.

PART II.

EDUCATION OF THE DEAF AND MUTE.

EDUCATION OF THE DEAF AND MUTE.

INTRODUCTION.

SCHOOLS FOR THE DEAF AND MUTE; UNIVERSAL SYMPATHY WITH THE DEAF AND MUTE; INSTRUCTING MUTES; HISTORY OF THE SCHOOLS AND OF METHODS.

"*La méthode est la qualité dominante de l'écrivain français.*"—VOLTAIRE, (Essai sur Milton.)

18. SCHOOLS.—When we enter a school of blind children, we feel their irretrievable loss of sight, and, naturally enough, we at once try to make them touch what they cannot see. This movement is so direct and spontaneous, that one is surprised, upon reflection, that it did not sooner lead to educational schemes, in which the touch, concentrated in the hand, would have taken the place of the regard (look) in their intellectual and professional training. But the question was not only one of physiology, viz, that of substituting one sense for another in the act of perceiving the outward world; it was also one of progressive morality, by which men become more and more enlightened upon the point of their duty toward the unfortunate, a moral sense of more recent growth than many imagine. But as soon as this moral sense began to be felt, it extended widely its sphere of action, and seems now incapable of being anæsthetized by egotism.

Moved by the same feeling, when we visit a school of deaf and mute children, we are moved, however, by a very different course of sensory impressions. Unwillingly or unwittingly, we speak to them often quite aloud; for though we are aware of the cause of their mutism, we cannot at once realize its irretrievableness. We perceive the silence of the deaf-mute, but we do not feel it fated in the irrevocable manner as the surdity of the blind, because an inward warning makes us feel that surdity is a radical and primordial infirmity, whereas the muteness of the deaf child is a secondary, and consecutive infirmity, which can be obviated by opening some other channel of perception of the speech instead of the lost hearing.

This secret intuition of the problem of the education of the speech in the child, mute only in consequence of deafness, has preceded our actual knowledge on the subject, helped us to acquire it, and has often supported the failing hopes of the teachers and friends of the mute. To this consciousness is due the long series of trials—apparently isolated by the old rule of the *secret among savants*—of P. Ponce, Bonnet, Wallis, Amman, Pereire, Heinicke; and now made public, according to

modern ethics, by MM. Hill, Hirsch, Saegert, Linnartz, Kratz, Cyrille, Van Der Wielen, and Misses Hull, Rogers, Trask, and others. Hence the problem of instructing the deaf to speak has lost much of its natural difficulties by the progress of physiological education, and much of its mystery by the impartial history of the preceding schools, and by the frank exhibition of the new methods and of their living results.

Is it right to say that we have come to a consensus in that matter? Among the schools which teach speech, there are yet discrepancies, mostly due to their origin; some tending to be smoothed away by free contact and discussions, others due to the inner genius of the different languages, whose disappearance, to make room for a fallacious uniformity, would breed evil. But between these schools and those who pretend to express all ideas by pantomimes, there is no possible fusion; it is all struggle; there will be a victor and a victim; one or the other must disappear by absorption. The contending parties are the schools of mutism, large, numerous, and supported by states or rich corporations; and the schools of speech, which have fewer pupils, smaller endowments, and a staff whose support is principally the intelligent knowledge of their subject and the heroism of their object.

During almost a century, the schools of mutism operated, and spread their *méthode des signes* far and wide. Now, the schools of the speech begin to gain strength and ground in their turn. They have elucidated and improved their methods, and secured new locations, or conquered old ones, as Antwerp, Brussels, London, Geneva, Jacksonville, Groningen. From this we can see that the magnitude of the philosophical problem is equaled by the extent of the battle-field; and can foresee that the interests engaged therein will extend far beyond geographical limits.

Our attention is first drawn to the respective positions and physiognomies of the schools of speech. There are three of them: the Hollando-German; the Spanish-French, and the Anglo-American, each twinlike.

The origin of the two first is enrobed in that secrecy which was the dress of science in former times, and which now renders more difficult the delineations of their infancy. But now the three schools are equally vested with the radiance of publicity, which permits us to see and describe their form, gait, and tendency. Therefore we are allowed to represent in our own minds these fair creations of other minds as coming out from obscure grottoes, inwardly connected, whose march is parallel rather than divergent, with a marked tendency to converge toward a bright point, which the eye can already determine ahead, where the three will soon form a strong and harmonious group. When arrived there, these schools will have conquered the future of the physiological method of teaching deaf and dumb children to speak, and, through the fullness of the written and spoken language, of educating them like other children.

CHAPTER I.

THE HOLLANDO-GERMAN SCHOOL.

HISTORY; EXTENT AND CHARACTER OF THIS SCHOOL; SUCCESS OF THE METHOD; COLLECTIVE TEACHING; CONCLUSION.

19. HISTORY.—About the beginning of the eighteenth century, Dr. Amman published, in Amsterdam, his two treatises "*Surdus Loquens*" and "*Dissertatio de Loquela*," by which he let men know that he was capable of teaching the deaf and mute to speak, but in which he says very little about his *modus operandi*. On this subject, Dr. Hirsch, of Rotterdam, says, in his "*Souvenirs*," p. 51: "If we ask what Amman was doing to give speech to his pupils, how he was developing their minds and hearts, how he applied the speech to other teachings, we find these books absolutely mute." In consequence of the law of secrecy at his time, Amman left neither school nor disciple, but the mother-idea, which Heinicke seized upon at the call of Buffon. But Heinicke himself published no method, and left only the pupils who had helped him in his school of Leipsic. Those initiated teachers began only after his death to disseminate his ideas, from which, by free discussion and open practice, our contemporaries have disengaged and embodied the principles of the Hollando-German school. This school is now represented by four veterans, who are named, in token of respect, by rank of seniority: Hill, of Weissenfels; Hirsch, of Rotterdam; Jankë, of Dresden; and Saegert, of Berlin, and by many other talented men, whose names will find their proper place here, as connected with some improvement of the theory or practice of their art.

20. EXTENT.—This school teaches speech to hundreds of mute children, from Breslau to Cologne, from Königsberg to Brussels, and even in England and America. (We have a branch of it in Broadway, New York.) It may be characterized by its dominant feature, imitation. This seems to be the only decided means of classifying methods, and we will find that the dominant feature of the Hollando-German school of teaching speech is "imitation." Imitation is not its only means; it is its principal means, the one by which, therefore, this may be represented as a school and differentiated from the others. This character is pretty well defined in the institution of Liegnitz. This school looks poor enough, but is supplied with five competent teachers for eighteen girls and thirty-two boys. The director, Mr. Kratz, takes hold of the new-comers, and exercises them at once, teaching mainly by imitaton, without forgetting to communicate to their hands during the lesson the powerful vibrations of his chest. "When I have thus given them a feeling of what the emission of the voice must be, with a certain amount of practice, any

one of my teachers is good enough for them," says M. Kratz. It is by this faith in his method and by his devotion to his pupils that he holds the first rank in his school, chief in the labor as well as official head; no *caput mortuum.* The same eager interest is observable in M. Linnartz, director of the school of Aix-la-Chapelle, and in others also.

I have said that imitation is the main character of the Hollando-German method; we must now observe the changes or modifications this method undergoes, without ceasing to be itself, when passing in its application from one institution to another; from Liegnitz to Brussels, for instance.

M. Kratz commences the teaching of speech by the guttural sounds; by those whose origin is the more internal or deepest. Brother Cyrille commences by the labials, whose sounds are of the most outward formation; progressing from the dentals and palatals inward and downward. Can the cause of this inversion of processes in the same method be, that the French language, taught by the latter teacher, is altogether more spoken by the external organs than the German? Facing this problem, the writer felt quite unable to solve it. How much we desired in particular to appreciate the modifications the method undergoes, when in practice it passes from the school of the Frère Cyrille in Brussels to that of the brother Van Der Wielen in Antwerp; both masters educated at the school of M. Hirsch, of Rotterdam, but one teaching his pupils to speak in French, the other in Flemish. Here we were at the intersecting point of the guttural languages of the north and of the middle buccal ones of Central Europe, and, by mere ignorance, were denied the satisfaction of solving this fine complicated problem of philology, physiology, and education. All that we could seize of it is, if we are not mistaken, that, 1st, The exercises of speech, as we heard them made in French and in Flemish—later in German—seemed to act differently on the chest; 2d, The more the voice taught to the mute is guttural, the more the chest expands in its exercise; 3d, The teaching begun by, or longer persisted in, the gutturals gives the children a stronger voice, or vowels sooner and better melted in the consonants, productive of the articular movements; 4th, The children who exercise their chest the most look hardier and stronger than those who do it less; so in the same ratio are they more free of phthisis and insidious pneumonia, which in the *schools of mutism* are the wolf in the sheepfold.

21. SUCCESS OF THE METHOD.—In the Hollando-German school, all the children learn to speak, and do speak, except those whose organs of speech are paralyzed, and those who are idiots besides, and who cannot be taught by the method of signs or by writing alone. But the cases of true idiocy are no more numerous among the deaf-mutes than among ordinary children, and paralysis of the organs of speech is generally consequent upon infantile convulsions and has no necessary connection with the organic causes of mutism. "It is demonstrated," said Dr. Matthias, of Friedberg, in 1858, "that the vices of the vocal organs are no more fre-

quent in the mute than in the hearing child; the organ of audition being entirely independent of the organs of speech, which, if found stiffened, are rendered so by inaction." M. Saegert had already stated, in 1856, in his remarkable Report on the instruction of deaf and mute children, that "ninety-nine out of a hundred of these children have well-formed organs of speech; they will learn to speak if their sight is good and their touch delicate; the more or less probability of success depends entirely upon the capacity of their teachers." Since these men of great authority have pronounced their judgment, after long professorships and inspections which lasted several years, the practice of more than forty schools has confirmed their conclusions. In all the Hollando-German schools, instruction is communicated in the national language, written or spoken; the language of signs and the manual alphabet being disregarded. M. W. Hirsch, the apostle of the Dutch schools, was never tired of saying, where he superseded the signs by the voice, in Liege, Brussels, &c., that "the worst methods are the mixed ones."

Under such masters, the practice of teaching speech is everywhere extremely simple. The most competent teacher takes the new pupils, as has been stated, one by one, two by two, and soon more at a time, and placing himself before a strong light in good conditions of directness, horizontality, attention, and mutual desire of doing well, he shows them how he moves, and how he can displace at will the organs which are used in articulation; how he inspires and expires at will great volumes of air, which will soon be rendered strident, by vibrations, to produce the vocal sounds. This first part of the study is intrusted to the sight; the child imitates what he sees. When the articular movements are thus made easy, and when the air is harmoniously expired in useful quantities, the vibrations of the sonorous voice have to be demonstrated. This demonstration can hardly be made by the sight, because it takes place in such cavities as the eye cannot reach. It is then, therefore, that the touch of the child must have been trained, and ought to be ready to perceive the vibrations of the organs in the act of speech, so that he can imitate them; and imitating the vibrations he cannot fail to utter the identical sounds they give rise to; that is to say, he speaks. Thus are acquired, almost separately, the three elements: position of the parts, expiration of air, and muscular vibration; the result, necessarily, is speech. We say necessarily, since the slightest change in one of these three factors unavoidably modifies either the articulation, the volume, or the thrill of the voice. This reunion, or harmonious melting, of these factors of the speech, position, expiration, vibration, is the key to the teaching of the language. At this important point, whatever be the method in use, the teacher owes great attention to his task; for he will meet there, as in the subsoil upon which he intends to raise a monument, many individual particularities, (idiosyncrasies,) which practice alone finds out and personal combat eradicates.

22. COLLECTIVE TEACHING.—The intimate character of this teaching

permitted the friends and professors of mutism to spread the scarecrow idea that to teach the deaf to speak, as many teachers as scholars were needed. They were simply calumniating a theory to do away with a reproachful practice. But after this initial period, the theory and practice of the art, though yet somewhat discrepant in different schools, have this in common, that, after the elements of the speech have been severally produced and corrected, the sum, synthesis, or spoken language may be and is actually taught—shall we say—collectively, or, using a pleonastic expression, by a single teacher for a group of children. This collective teaching is so well classified in Holland and Germany that the composition and the form of the groups are almost stereotyped by experience. The group is a class of speech, if you please to call it so, but it is more than that on account of its elliptic shape. The master, standing at the head of an oval table, faces the light, and the children, standing too, surround the table, all looking into his mouth. There may be six, eight, or many more in the group. The less experienced stand directly opposite the master, and, gradually making room for new-comers, stand aside to learn also to read the speech upon its most external and lateral muscular movements.

Besides, this collective teaching of the speech soon becomes interwoven with those of writing and reading, with lessons on drawings and objects, and other educational matters, in the order in which they are presented to ordinary children. In this manner, speech becomes, concurrently with writing, the ordinary form of teaching; otherwise illustrated by examples, drawings, figures, as circumstance brings them forth. It has been said that this was the uniform practice; for indeed we cannot call two improvements, to be found in the northern schools, "diversity of methods." One is the series of admirable drawings of M. Hill, of Weissenfels, in which every cartoon represents familiar objects, grouped according to the order of organs moved to pronounce their names, and which help so much in the lessons of speech that they can be found even in the American schools for idiots; the second improvement is the preparation, on all the tables and the accessible part of the walls, of blackboards, on which to write and to rub out, as ideas fly, the incidental teaching.

23. CONCLUSION.—A few remarks, apparently disconnected, but really united into the main body of principles, are yet necessary to complement the impression made by the Hollando-German school. I will express them as they come to my mind, without pretense to a systematic arrangement.

The schools for the deaf and for the blind are sometimes contiguous, and managed by the same director. This plan serves several purposes. For instance, under it the two classes of invalids are rendered capable of helping each other. This reciprocity of services may serve, under skillful management, to create among them bonds of affection, and to create a moral sense in children said to be made selfish by isolation.

Moreover, the number of servants is diminished and the number of efficient teachers increased in the same ratio.

In the same moral direction, the tendency is to substitute, as much as possible, the externat for the internat; to open many small day-schools in lieu of vast barracks, where the natural feelings of youth are trampled upon by a mechanical discipline which invites hypocrisy; day-schools which accustom the children, after training-hours, to habits of labor, to help their parents, (which is a good training too,) and to enjoy their home and natural society, which constitute by themselves a strong and practical education. In Holland, particularly, the children are very much occupied between school-hours at some simple and useful work; later on, they are kept only a few hours daily in the institution, and are supplied with occupation or apprenticeship outside; so that, when their education is finished, the pupils have not only acquired capacities conformable to their taste and station, but have formed previous associations in the world, which they enter, not like strangers and awkward cripples, but as old acquaintances, or mates with whom the people are used to speak and labor. Almost anywhere in Germany, and all over Holland, the deaf children of both sexes are educated together. This creates an emulation which makes the school attractive, and stimulates the pupils to advancement, particularly in speech. There and thus begin these appreciations of each other, true, because they are immediate, direct, and quotidian; there also are born those reciprocal feelings, some friendly, some more intimate, which, helped by full interchange of ideas, become so pleasing or useful in after life, and lay the foundations of future happiness.

On the western banks of the Escaut it is different. In Belgium, the policy whose task it is to place between woman and man a priest or a devil—sometimes both in one—has everywhere separated the sexes, even where sex does not yet exist, and, moreover, where nature had already sequestrated the individuals by the double partition of dumbness and deafness. The instructors of the mute whom we have seen there, and whom we have named with due honor, are the pioneers of the work, and as such they are full of a holy enthusiasm, and have developed, with rare intelligence, qualities almost maternal. Such are all beginnings. But after these devoted men, there will follow as usual the ambitious, the indifferent, the needy, the poor of mind, the rich of bestiality, in which the dryness of heart of a unisexual existence leaves room for a satyriasis contagious among children educated in unnatural conditions.

Giving a last look at the prosperous school we have just studied, we remark that the same influence which deprives children in Belgium of their natural companions, deprives them in Germany, more generally than in Holland, of their natural teachers—who are females, of course—particularly as teachers of speech. This practical blunder can better be explained by traditional habits than by wrong judgment or ignorance; since the Germans know that the Americans employ on the largest scale,

and with the most marked success, the educational capacities of women, capacities recognized to be far above those of men, where technical teaching does not require energy, nor the art muscle.

But, next to the great school of Dresden, where one hundred and twelve young ladies and young men are learning to speak, and where they receive the most thorough education, the director of this school, M. Jankë, has already founded for very young deaf and mute children, an institution, whose name alone reveals the inspiring idea and insures its success—*the Filiale!*

The *Filiale* is a pretty residence, of moderate dimensions, where thirty-four children, of both sexes, (age three to nine,) are intrusted to three married couples, who treat them like their own; they live with them, and teach them mainly to speak during and about the most trivial circumstances of home-life; indeed, at any opportune moment. A cheerful house, trees, flowers, living birds and fishes, playthings, and maternal cares—such is the *Filiale.* Other leaders of the same school present a similar example. At the instigation of M. Hirsch, several Dutch teachers of the mute have crossed the Channel, and one of them, M. W. Van Praagh, has opened in London a school where these children will be treated as at home—a *Familiale*, as M. Jankë could say. There speech will be taught after the Hollando-German method, next to the new English School. Upon a free ground, where philosophical questions will be treated in daylight and not solved in the green cartons of a *commis*, there will be comparison, discussion, and progress.

CHAPTER II.

THE SPANISH-FRENCH SCHOOL.

HISTORY; PEREIRE'S METHOD; OPPOSITION TO PEREIRE.

24. HISTORY.—The history of the Spanish school opens with the revered name of P. Pons, and the book of Bonnet, (1620.) What remains of this antique tradition is this: Bonnet published the Spanish manual alphabet, gave a theory of the order in which the syllables ought to be taught, and suggested the use of a flexible leather tongue to imitate the positions of the living tongue in the act of speaking.

More recently, Hernandez proposed to use images representing the various positions of the organs of speech, while Hervas proposed to employ a vertical section of the head and neck of the skeleton to show the passages which articulated language follows.

At the exhibition of Arragon in 1868, the school of Madrid exhibited photographic charts representing the organs of speech in the act of pronouncing each sound; and at the exhibition of Vienna, hardly closed, Don Carlos Nebreda y Lopez, director of the same school, presented a report on the combined teaching of the blind, deaf and mute children, and a treatise on the art of teaching the latter to speak. This book is remarkable for a series of lithographs representing the external positions of the speech, and besides for the dotting of the course of the sonorous air, from the larynx out, to form the various sounds. We have also seen the same lithographs rolled at the foot of a mirror, so that the pupil unrolling them can study alone and rehearse every position. He has thus at once several terms of comparison: the letter written, and figured with the hand alphabet; the image of the movements he must imitate; the track to be followed by the sonorous air through his own organs; his own image in the looking-glass, to be compared to the lithograph below; and the tactile impressions received when the voice passes from the depth of the cavity to one or the other issue of the speech. This mode of self-learning, in the interval of the formal lessons, must be valuable, particularly where the children are many and the school poor. But Don Lopez has also exhibited in Vienna his pupil Martin de Martin y Ruiz, deaf and dumb from birth, and completely blind from the age of two years; he is now eighteen. The education of this lad was commenced in 1869, and now, after four years, he speaks, reads, and writes. He understands the questions of moral and of personal hygiene I know, and those of religion, as I was told. He is well read in grammar, geography, natural history, arithmetic, and geometry. To make my acquaintance, he proceeded as he would have done to show a knowledge of the problem of the hypothenuse with the solid forms of his school; he measured,

first, my thickness from sternum to spine, using his two hands like the extremities of the branches of a compass; then, with one hand he followed my chest and arms, when with the other, having reached the occiput, delicately as a girl he touched the contours of my face and carefully mapped out the barren field of my calvicy, like a land-surveyor. He knew what I was henceforth, and became quite affectionate.

The method made use of for him puts in relief the advantage of uniting in the same locality and under the same leading spirit the school for the blind with the one for the deaf and mute, as the French republic had done in 1794. Thanks to this combination of means, Martin Ruiz learned the spoken language with the deaf and the written one with the blind. All his instruction was completed by his alternate passages from one of these schools to the other; and he succeeded because both were only one for him. This young man is in himself very interesting by his kind feelings, the quickness of his perceptions, the vivacity of his emotions, and also *in memoriam* of Laura Bridgman.

The result of this, too short, review of the actual labors of the Spaniards, at the very cradle of the art of teaching the mute to speak, is, that they have religiously kept alive the sacred flambeau. In the mean time, however, the art had passed the Pyrenees with Jacob Rodrigues Pereire; from Spanish, becoming naturalized French, with himself.

In 1734, Pereire, hardly nineteen, was already gathering the scientific materials on this subject. What cause could have impelled so young a man in such a difficult undertaking? "*L'amitié et la communication d'une personne muette lui ont suscité cette idée.*" He does not say more; but it is easy to comprehend that, without this friendship and communication, Pereire could never have instituted the experiments upon which he founded his method.

In 1745, he produced, before the academy of La Rochelle, Aaron Beaumain, who was not his first pupil.

In 1746 he presented to the academy of Caën his pupil d'Etavigny, born deaf, but speaking at this time.

In 1749, and in 1751, having removed his school from Bordeaux to Paris, he presented his pupils to the Academy of Sciences, which nominated a commission to examine into "the method used by M. Pereire to teach the deaf and mute children to speak and reason." The commission, composed of Mairan, Buffon, Ferrein, made two reports, which are to-day historical documents. To be short, I will give only the concluding lines of the second: "Cet exposé fait voir que M. Pereire a un talent singulier pour apprendre à parler et à lire aux sourds et muets de naissance; que la méthode dont il se sert doit être excellente; les enfants qui ont tous leurs sens ne faisant pas communément autant de progrès dans un si petit espace de temps. * * * Cela suffit pour confirmer le jugement que nous fîmes dans notre rapport du mois de juillet 1749; et pour faire sentir que sa méthode d'instruire les muets ne peut être que très-ingenieuse, que son usage intéresse le bien publique, et qu'on

ne saurait trop encourager celui qui s'en sert avec tant de succès. Signé: Mairan, Buffon, Ferrein. Je certifie le présent extrait conforme à l'original et au jugement de l'academie. Signé: Grand-Jean de Fouchy, secretaire perpetuel de l'Academie Royale des Sciences."

Well! These commissaries of the academy, whose moral sense was almost as keen as is ours, did not deprecate and revile him as others have since done, because he showed them the results of his method, but kept his method itself as his own. The commission concluded, from what they had seen, that "the method must be excellent, and that the one who applied it with so much success could not be too much encouraged." They did more: they permitted the reprint of their report, *en suite*, of a note of his in which the school-master offers his services to the families who have deaf and mute children: would-be departure from an unborn morality which cannot fail to excite the contempt of the society which leaves in penury the children of Daguerre, who gave it and the world photography.

But is it true that Pereire kept about his method the absolute secret upon which rose such reprobation? Did he not show enough of his method, and more than was needed, to make it comprehensible, even to a generation which had none of his pupils to see and to compare with his sayings? What did he keep secret? The method itself the reporters of the academy understood thoroughly; or the *modus operandi*, (*tour-de-main*) which he was reserving for his family as an eventual *gagne-pain*?

It would be good to investigate this point, not so much for his justification as for the complete restoration of his art. To do this there is a difficulty resulting from the destruction of all his manuscripts and papers in 1793. We have therefore only a few of his own words, and a few pages of his pupil, Saboureux de Fontenay. However, let us see. In the speech which Pereire delivered in 1746, before the Academy of Caën, he said: "The consequences which I drew from a great number of observations, and the result of said practice upon several deaf children, opened to me the hope of succeeding, before I knew the true obstacles; the greatness of these obstacles not allowing me to see them altogether. I think I overcame them, only because severally, and one after another, I thought I was fighting the last of them."

Which were these successive obstacles which I must indicate—though having no room for their description—because from their comprehension will resort the Pererean method.*

Before Duverney had published his superb Anatomy of the Ear, Lecat his Physiology of the Senses, and one a Treatise of Otology, Pereire had distinguished the deaf and mute proper from the children rendered mute by the ill-formation of the organs of speech, or by local paralysis subsequent to infantile convulsions, or by idiocy and imbecility, differentiation which requires yet to-day a good diagnositian, (p. 224.)

*The texts of Pereire, Saboureux, de Gerando, &c., can be found in a "Notice of Jacob Rodrigues Pereire," 12mo., G. Baillière, Paris, 1847, from which we will quote.

Having thus set apart "the mutes which were the objects of his art," he divided them into three categories, which are yet classical: the deaf, who are absolutely dumb, who are the less common; the half-dumb, who hear strong noises, and voices even, but without distinguishing their sounds, who form the larger class; and those quarter-deafs who distinguish some voices, and thereby have acquired some idea of the language. This third class would be the more numerous if it were not early reduced by death from many infantile diseases and constitutional affections, (p. 226.) These categories were made the basis of his teaching, which was thus attributed:

To those who heard nothing, the complete method, and particularly the most thorough substitution of tact for audition.

To those mutes who, like Saboureux, showed a difficulty of articulation, the teaching was made more particularly in writing and through the dactylology, in which, however, every particular position of the fingers indicated the disposition and action of the organs necessary to produce a sound, altogether with the characters or letters representing these sounds, according to usual orthography. (P. 269.)

To those who heard the sounds in various degrees, comparing their sensations of hearing with the ones we could experience from the sight if several thicknesses of fine gauze were placed between our eyes and the objects, (in which hypothesis the number of gauzes would correspond to the divers grades of surdity, p. 259.) Pereire managed various gymnastics of the auditory apparatus, by which he succeeded in "making them distinguish, even without the help of sight, a more or less number of articulated words, and some of the pupils became able to extend this knowledge to all the words." (P. 257.)

25. PEREIRE'S METHOD.—Let us come now to his method proper of teaching the mute to speak.

It is quite certain that Pereire, like the other teachers of the dumb, substituted the regard for audition, and with it used the resources of imitation, as well as did the Spaniards, the Dutch, and the Germans. But we must look elsewhere, and mainly in his reticences, to find out the very core or principium of the method which he founded, and which he thought he had a right to transmit to his children, as an intellectual heirdom.

We will find it in the stimulus which lightened his task, and moved him onward during forty-six years. "The friendship and the communication of a mute person suscitated to him that idea," and we must add, for the full comprehension of the problem, that this same amity allowed him to continue, and to co-ordinate the experiments which he could never have begun without this friendly communication. Is not woman at the bottom of any good accomplished by man? "What?" will some one say, "was it experiments of the tact; and was Pereire trying to substitute the sense of touch for the lost sense of hearing?" Precisely. Pereire, often discontented with the services rendered by the sight in the reading on the lips and speech, as taught by the authors, undertook a long

series of experiments, which a dear reciprocal feeling could only make and undergo; and adding to the results of these experiments those of observations, taken upon a great many other deaf and mute persons, and particularly upon babies, he founded his method upon this tactile experience, as novel as it was extensive.

But I had better allow him to develop the same ideas with that peculiar and clever style, which makes the loss of his other writings doubly felt.

"All deaf and mute children, not excepting those of the first category, (above referred to,) form, of themselves, some cries and articulated sounds, more or less distinct—a natural ability often very useful. One can understand how children who have no idea of sonorous voices can, nevertheless, form some of them, and use them quite correctly in an emergency, if one reflects that they do not need, more than any other children, to learn how to cry when new-born, and in the following months to emit a few articulated sounds. To that effect, the babies need not hear; it is sufficient for them to imitate certain dispositions of the organs, which they can readily perceive in other persons by the touch and the sight, and whose circumstantial occurrences soon reveal to them the meaning and the opportunity. For surdity, of whatever degree, cannot prevent a child from *feeling on the bosom of his nurse the vibrations caused in the cavity of the chest by the emission of the voice*, nor from noticing the movements of the lips, which are invariably concomitant to the exit of the speech.

"And, moreover, the more dumb a child, the better able will he be to feel early these effects of the voice, foreign to the hearing. * * * These considerations led me to think that several deaf and mute children, who are thought to have lost their hearing by accident, because they have been heard pronouncing at first more words and more distinctly than afterward, are, nevertheless, dumb-born children, who, when quitting the arm upon which they were first carried, forgot in part, or *in toto*, what they had learned by the tact on the chest of their nurse, and retain of their former baby-speech the only articulations which are perceived by the sight. I also believe that it is equally by the concourse of the tact (besides the sight and the hearing) that ordinary children learn the first words or semi-words which they utter; and that, being yet incapable of the steady application of mind which reflective imitation demands, they would remain speechless longer if those who live with them did not show their faces, did not carry them, nor enter in other contacts with them when speaking. Thus—and this is a new and surprising fact—the deaf and mute children perceive the speech by the tact. This sensation takes place when, speaking to the dumb, one brings his mouth in contact with the ear, face, or other sensitive part of the body, like the hand. Then the air which forms the speech communicates to these parts impressions as frequent and distinct as the syllables themselves, vibrations which are sufficient, without any other means, to give a clear perception of several articulations. So it remains demonstrated,

as by the example of the young d'Etarigny, (before the commission of the Academy of the Sciences,) that the deaf of the first category—that is to say, perfectly dumb—will be able to distinguish some words by this process.

"The mutes of the second class are capable of acquiring more of this knowledge than those of the first. According to my experience, the deaf of the third category, who are able to distinguish differences between the vowels, are the only ones who can be trained to hear with the ear, (*auriculairement.*)"

After the ennunciation of these principles, Pereire concluded his communication of 1763 to the Academy by affirming before the commissaries Mairan, Buffon, and Ferrein, his witnesses and sponsors since 1749, that "he, Pereire, was the first who had found out the means of using not only what was left of audition in a great many, but the *tact* of the deaf and mute children, to give them the use and the intelligence of language," (pp. 278–284.) And this in virtue of the law which he gave in advance of all his contemporary physiologists, "*Tous les sens accomplissent leur function en vertu d'un toucher plus ou moins modifié,*" (p. 185.)

The discovery of Pereire, considered here only as an institutor, consists, therefore, in the application of this law to the teaching of the children rendered mute by deafness, and in substituting to audition other modes of tactility, particularly the immediate contact, (*le toucher immediat.*) It consists also in the physiological education of the sense of hearing in the children of the third category, who naturally distinguished some vowels. There is the secret so well hidden. We have it written by Pereire himself in the *Comptes rendus de l'Académie des Sciences*, (*Mémoirs de savants étrangers*, 5th vol.,) more clearly and much more explicitly presented than here. In this fifth volume, dactylology is explained as one of the instruments of instruction for the mute, a means of communication of speech during the first apprenticeship; another to represent and recall all the positions of the organs during the lessons of articulation, (by the bye, in striking analogy with the signs of Bell, further spoken;) a last resort, to express themselves for those unable to speak freely, from whichever cause, among the ones above enumerated. The dactylology of Pereire was also a language (by the tact) for the mute in obscurity or in company, when willing to communicate only with one person in a crowd. Used largely in this wise at the school, and even by the parents of the pupils, it suggested to Saboureux the idea that the blind, too, could be taught by the touch, (p. 267;) a suggestion repeated ten years later by the Abbé de l'Epée, and since carried out by Haüy. Dactylology was able to express also mathematics, music, the rhythms of poetry, and the accents of oratory and of the human passions, (p. 266.)

The speech was taught by imitation, with the regard as a guide of the internal positions in the mouth and external muscles of the face and neck; and for the first known time with the tact, conductor, and

monitor of the innermost positions, and of the organic vibrations which concur in the emission of sonorous articulation. By this method, the mute from deafness, of an ordinary capacity, could learn to speak in twelve or fifteen months.

How did Pereire attain this result?

By observation upon nature, with no other *parti pris* than the intense desire to do good, first upon and for a beloved woman, then on dear mute children, even in the arms of their mothers. That is the reason why the author of the best "Physiology of the Senses," Lecat, admired Pereire. The father of Emile and of Eloïse visited him like a friendly neighbor, and Buffon opened to his name and to his work a page of the immortal "*Histoire naturelle de l'homme.*"

26. But, alas! that is the reason why the priests of Caën, Bailleul, and Cazeaux, the fathers Vannin and André in Paris, in Orléans the Abbé Deschamps, and later the Abbé de l'Epée and his sequel, hunted him unrelentingly, clamoring for his method—that is to say, his own arms—to beat him with them, in the name of humanity. And what answer does Pereire give to those claims, well concentrated in the acrid charity of the book of the "*Institution des sourds et muets, etc.*"? He visits the rival school, and seeing the gesticulations which go by the name of "*language des signes méthodiques,*" mildly said: "I could not believe it, if I had not seen it, sir; you have, like the Chinese, as many signs as there are words." The truth was yet lower than this criticism. To his friends, expressing disgust for the anonymous attacks, he answered, "I shall be mistaken if, whatever may be the self-love of the author, his religion does not soon make him feel how wrongly he has acted toward me."

This said, he left for Bordeaux, to die where he had begun; dying, indeed, without completing this last sentence, which must be read by the light of the unjust assaults of his rivals: "Praying the Almighty God to inspire my heart with feelings of justice * * *."

THE ABBÉ DE L'EPÉE AND HIS TIME.

HISTORICAL SKETCH; THEORY AND PRACTICE; FOURCADE; HIS WORK AND HIS REWARD.

27. HISTORICAL SKETCH.—The Abbé de l'Epée began quite late in life to instruct deaf and mute children. He was rounding his sixties in 1770 when he opened to them his house of the rue des Moulins, near the school of Pereire, already old and famous, in rue de la Plâtrière. However, he then knew neither Pereire, Amman, nor Bonnet, and entered upon a career, to him, absolutely untrodden, (*Institution*, &c., part 1, page 9.) But at the start, his charity, even without tradition, was a good guide.

He understood at once that what the deaf cannot understand must be shown. "Have we but one sense? Or can the failing of one be supplied by the ministry of another?" (1, 26;) and as a corollary: "The

only means to render deaf-mute children useful to society is to teach them to hear with their eyes, and to express themselves—*de vive voix*—with their voice," (1, 155;) then he adds: "The deaf and mute can speak like us when they are instructed;" (2, 56;) "to teach the mute how to dispose his organs to emit voices, and form distinct speech, is an operation neither long nor painful. Three or four lessons advance this business very much, if they do not thoroughly accomplish it, in following the method of M. Bonnet, a Spaniard, printed about one hundred and fifty years ago. Then the children need only acquire the usage; and this does not concern me; it is the business of the persons who live with the pupil, or of an ordinary reading-master," (2, 9.)

Having disposed of the problem so summarily, the Abbé de l'Epée puts his theory in practice. "When it pleases me, I dictate my lessons *de vive voix* (*viva voce*) without making any sign. I speak with my hands crossed behind my back; the persons near me do not understand what I say, because in their presence I purposely whisper, suppressing all sounds of my speech. However, my deaf pupils, seated farther in front, understand what I say with their eyes, and write it or repeat it at will. This is the more remarkable, since these children come only on the days (Tuesdays and Fridays) and hours set apart for their lessons. Moreover, I seldom repeat this experiment, because the *language of the methodic signs* is the shortest and the easiest to understand. If masters were giving their time to make their pupils speak daily, the deaf and mute children would soon get into the habit of speaking, and would be debarred of conversation during the darkness only." (2, 57.) "It is certain that once in a while we dictate our lessons *viva voce*, without any sign. The operation is a little longer, and this prevents me from making an ordinary use of it, for which I am ready to acknowledge that I may be wrong." (2, 24.)

Was it this delicious and fatal feeling of laziness, which invents the straight line and tempts us to follow it even through fire, instead of the undulating and secure paths, which nature has everywhere opened to final success and happiness, which captivated de l'Epée? Was it the introduction in his class-room of the Pereirean element, which began to hunt the new master during his lessons of 1772, under the form of Saboureux de Fontenoy, auditor with his eye, erudite scrutinizer, pugnacious, reticent? Or were the difficulties of the problem becoming more complex and tantalizing every time the new master had declared them solved and conquered?

Be the cause as it may, it is evident that from this course of 1772 onward, the institutor of the rue des Moulins lost the philosophical sense which, in default of special erudition, had directed his first steps in his benevolent way, and lost also his urbane temper, since it became impossible for him to ignore the old master of the rue de la Plâtrière, loaded twenty years before with the praises of the Academy, pronounced by Buffon.

Saboureux had taught him the Spanish alphabet, (1, 103;) had demonstrated the inanity of his *langage méthodique des signes*, and predicted its discomfiture, precisely as it happened, but at the same time had refused to surrender the dactylology and the whole method, which his master was using to make his pupils speak, and even to communicate to them his Gascon accent. (Buffon.)

In the mean while, however, the more discreet Saboureux became, the more the Abbé de l'Epée wished to know; the more the latter taught his pupils to speak in a few accidental lessons, the less he could continue without a slow and sure method; the more public orations delivered by his pupils, the more his artifice culminated over the art. They were prepared to argue about the sacraments of the church in four languages, and to discourse on the finite and the infinite, "these speakers of recent manufacture," as their manufacturer jocundly called them. A lad of twelve was dressed to sustain in public Latin scholastic theses. But it was becoming impossible to continue this crescendo of miracles, even before the small-headed princes and duchesses of Vatteau. Therefore, the fourth exhibition of this kind, besprinkled with *magnificats*, was the last. The Abbé de l'Epée had to present his work to the public in book-form.

In this book, "*L'institution des sourds et muets par la voie des signes méthodiques*, *Paris*, 1776," the author, who withheld his name, was evidently nervous. He felt that he was doing a grave act, the particulars of which would sooner or later be investigated. In his evident emotion, he first transposed the order of his publications, the order in which his ideas had proceeded from each other from 1771, and which was like the key of his own mind during the last six years of the incubation of his system. By this transposition, he embroiled for himself, as much as for others, the intellectual processes through which he and they passed. So he says, (2, 5:) "The method which we publish to-day is anterior to the lessons reported in the second part." "If we had not previously formed it, it would have been impossible to prepare the deaf and mute pupils for the exercises." Again, at 2, 46: "It is to necessity alone, and not at all to profound reflections, that we are indebted for the combination of our method. We had neither formed, nor even foreseen, its *ensemble* when we gave the first lessons."

Almost all that second part of the book of the *Institution* is admirable in faith and convinced ignorance: the *institutor* mistakes and persuades like an apostle; but as soon as he feels that he has gone astray, discontented with himself and others, his argument assumes a querulous form painful to follow. Thus, in the first part of the book, the abbot soon becomes an author by his passion, and though he deprecates the character, (1, 13,) "*Il n'est point question ici, de la jolie d'être auteur*," he begins all at once a dispute of a seminarist. M. de Gerando cannot hide the fact: "Pereire never rose to dispute the method of the Abbé de l'Epée; it was, on the contrary, the abbé who himself opened the combat."

According to the rules of the clerical duel, the abbot gave to Pereire the benefit of the first fire, by quoting some parts of the reports of 1749 and 1751 to the Academy of Sciences, but continued with a fragment of the old programme of Pereire, which the reporters had printed. "The said Pereire divides his instruction into two parts—the pronunciation and the intelligence. In a few days, he (Epée) teaches his pupils to pronounce some words. To instruct them in the first part according to the methods of Pereire, it takes twelve or fifteen months; in the second, it takes more time. Exulting at this avowal, the new master, who teaches his pupils to speak in a few lessons, derides the old one, who needs fifteen months to do the like, and declares the old method 'excluded' by this avowal itself, and proposes as a substitute for it—what? His own expeditious teaching! This means the use of his methodical signs. We will now compare them with dactylology," (1, 25.) In the 203 pages which follow, not a word is said of Pereire, who, in 1749, had already exhibited before the Academy children born deaf, yet rendered capable of reading, writing, and distinctly pronouncing all sorts of French expressions; capable of giving accurate answers to unexpected questions; conjugating verbs; knowing the rules of arithmetic, (first report.) But the Pereire there unmercifully hunted down was the inventor of dactylology. This would-be dactylology, against which the Abbé de l'Epée let himself loose, was the same used by himself, like Pereire, with beginners, (1, 92,) and which he advised his followers to use too, (1, 161) yet it was not dactylology; it was the Spanish manual alphabet which Saboureux had taught him, (1, 103.) But Saboureux was, of all the pupils of Pereire, the one who spoke the least perfectly and willingly, because his education was commenced when he had passed his thirteenth year; and, his organs lacking suppleness, he always preferred dactylology and writing, in which he was very expert, to speech. The Abbé de l'Epée, who knew him well, could not be ignorant of this fact; yet he argued all the way as if he knew it not. He had copied the reports to the Academy, in which was detailed the progress in speech of several pupils, and nominally that of Saboureux; yet he obstinately represented Pereire as an exclusive professor of dactylology. Was he sincere? Did he forget his own handwriting and proof-correcting, as he had forgotten the phenomena of conscious cerebration which had given birth to his own method? Indeed, if any other man's sincerity was at stake, one could believe that the scholastic jargon of the *Institution*, apparently directed against the dactylology, is in reality aimed at Pereire by "this folly of being an author," (1, 13,) which the Abbé de l'Epée distrusts so much, and not without apparent reason.

But as none of us carry our untold grief to the tomb, if we find a chance to vent it in this world, the new teacher of the deaf and mute at last exhaled his chagrin: "It would have been desirable that M. Pereire had given to the public the means he used in his instruction. If they are better than ours, the present and future will be grateful for

them. But the Academy told us that he keeps it secret. He made it a mystery, forbidding expressly his pupils to tell how he instructed them," (1, 23.)

There is the real object of the publication of the book "*De l'institution.*"

Pereire wants to sell his method, or to keep it as an heirloom for his children. L'Abbé de l'Epée offers to give his for nothing. "I do not want any other reward in this world. I expressly declare I would not accept any other; *gratis accepistis, gratis date*," (Matth., xviii.) Pereire considers his method as his own, acquired by more than forty years' hard, unrelenting, unprofitable labor; the produce of that field of labor whose property should be held sacred, his encephalon.

De l'Epée is an abbot—that is to say, without family duties—and has no more apparent object in this world than "the folly of being an author." In exchange for a name he offers his method *gratis* to society.

Fatal present! Harpagon accepts, and the deafs are recondemned to mutism. The "*Institution des signs méthodiques*" will rivet their two infirmities into one: for the first time they will be deaf-mutes; that is to say, deaf without hope of speech. Bring forth the padlock, which we have seen on the frontispiece of the book of Bonnet (ed. 1619–20) for the mouth of the child born deaf; pass it again through his lips, and hide its key away for upward of a hundred years!

But that is not all. The eighteenth century was paved with abbots,—regular clergymen broken up. Between those abbots who courted pure science, like Nollet, or hunted for an ideal like de l'Epée, and those who entertained, in a used-up aristocracy, erethism by erotism, there was the floating mass of the needy, whose great problem was, how to live. The fame of the two schools of the deaf and mute children attracted them, (Deschamps, &c.) They harassed their first institutor and betrayed their second. The Abbé Sicard, not content with modifying the method of the signs of his master, and giving it his own name, without making it more serviceable, organized the padlock-application on a large scale, with which were silenced the teachers who dared to make the deaf speak in the .... No! I will write that name no more. When I wrote it, I did not know all.

The *French school*, approved by Buffon, is most interesting for its progress in language.

The abbot's school was that of mutism. I have only a few words to tell of its fate.

The mimic signs are natural to man. As his education and language are more limited he makes the more use of them. The one who disposes of a correct and colored language has no need to add any pantomime to it. *Per contra*, the deaf, left dumb, having no other means of expression, tries to render all his feelings by gestures, and succeeds to a limited extent. This last observation suggested to the one who had promised, and more than promised, alas! like Pereire, to make the mutes, born deaf,

speak, the idea of substituting, to the spoken language, the "*langage des signes méthodiques*," &c. He succeeded in the strictly natural limits of the gestures, and even attained to a picturesque effect by the wittiness of a few mute pupils. But, in the grammatical and philosophical order, de l'Epée and his successors in vain turned from the "*gestes naturels*" to the "*langage des signes méthodiques*," trolled thence to the "*langage des signes naturels*," and whirled around to the "*langage naturel des signes.*" The deaf pupils invariably refused to use this language in their intimate relations; de Gerando condemns it; Bebian demonstrates its inanity, (*Méthode*, &c., V. Gabel, p. 110.) The more they circumgyrate, the deeper they enter into the *pas-de-vice* without an issue; simply because they were unwilling to acknowledge, not only the fault, but the whole fault. Thus the Abbé de l'Epée was written down a failure, (*il échorra, de Gerando.*) Several men of talent tried in vain to reconstitute the language of the signs which bred only error and confusion," (V. Gabel, p. 112;) but none dared to repeat the first word of the Abbé de l'Epée—better if it had been his last too: "The deaf can speak like us when they are instructed, and the only means to render them to society is to teach them to express themselves *viva voce.*" There is the Gordian knot which nobody dared cut; in France, at least. The official school of Paris, which ought to have been the field of culture of the speech for the mute protégés of Pereire and dé l'Epée, remained a fallow ground, because, if it had been plowed, the bones of the immortal dead would have come on top of the furrows. "Is it not enough for your glory to be destined to partake of mine?" wrote, to the ambitious Abbé Sicard, the modest anonyme who had unsuccessfully fought in himself the folly of authorship, (de l'Epée in De Gerando.)

But the glory of the Abbé Perrier overtopped that of his predecessors. One thing alone remained of Pereire, his dactylology, intrusted to Mlle. Lemarrois. Vainly had Sicard beseeched for it. "You are the last man to whom I would surrender it," proudly answered the old dame, and octogenarian. She came to Paris, where I heard her, to give this patrimony to the children of her benefactor. But these young men, feeling incapable of bearing the burden under which their grandfather and their granduncle had succumbed, brought the dactylology, the key to the labors of Pereire, to the Abbé Perrier, who *mislaid* it. His glory is to have buried, in the *rue d'Enfer*, the last dactyle osselets of the master.

After this, the voices which at intervals rose from this silent enclosure were sedulously drowned. Bebian was severely punished for having tried to surpass the aforesaid "glories." Ordinaire lost the direction; some professors had to leave for mere essays at speech-teaching; whilst others, succeeding too well abroad, were invited in the school, there to be officially strangled, as the fly is at the invitation of the spider on her cobweb. I name Professor Dubios, born deaf-mute, now speaking and teaching, with his noble sister, other deaf-mutes to speak. So, too,

the last director, M. Louis Vaïsse—of the school of M. Gallaudet, in America, twenty years a teacher of mutism in New York, I think; first censor, then director, of the institution of Paris, but converted—like Dr. Gillet of Jacksonville, Brother Cyrille of Brussels, Saegert of Berlin, and others, to the art of making children born deaf speak, who published in 1870, his "*Principes sur l'enseignement de la parole aux muets*," the result of his own experience in the class of speech founded by Itard—Louis Vaïsse was permitted to present his titles to retired pay—Byzantine phraseology for expulsion.

What class was this?

In 1839, Itard, my guide in the art of educating idiots, died; and after having, in his capacity of surgeon resident in the institution for forty years, seen everything done in it, and noted everything left undone, bequeathed his fortune to found the teaching of speech. His money was taken, but his normal school of speech lasted only a few years. M. Vaïsse had become at once useless and compromising.

In the mean while, M. Fourcade, an original, it was said—but without originality would he had given his life to a heroic undertaking—commenced, about 1864, to instruct the dumb to speak. His former studies of the art of speaking had been done with the view of improving its histrionic powers; his subsequent ones with the view of improving the pronunciation of the French, which leaves—let us acknowledge it with pride for this language itself—great room for improvement, and the latter studies of M. Fourcade had for their main object the application of his past experiments to the teaching of speech to the mute. This method, result of this triple observation of the same phenomena, is not published. But from the papers which call the attention to his lectures and pupils; from the reports of official commissions upon the results of his lessons; from correspondence, private, though of doctrinal interest, one can infer that the method used by Professor Fourcade is based on sound knowledge, and forms remarkably clear-speaking pupils. With the assistance of anatomy he has made photographic collections of the positions of the external and internal organs during speech, and he uses them to demonstrate to his pupils the positions they must assume in being trained. By his knowledge of the physiology of the voice, he has, more than anybody else, if I am not mistaken, insisted upon the effects of the voluntary movements of the diaphragm, which gave such force and continuity to the voice-qualities attested by those who have heard his pupils—and upon the proportion which must be established between the quantity of vocal and articular labor asked, and the quantity of air which the lungs must furnish to accomplish this labor. He has also instituted valuable passive exercises of the muscles of the face and neck, which a long silence in infancy prepares for atrophy, and final paralysis. It is by these local gymnastics that Professor Fourcade has obtained from his pupils a pronunciation more continuous and harmonious than generally comes from the mouths of deaf children

educated to speak. Such is the opinion of the father of one of his pupils, M. Guénon, chemist of Paris, who, before trusting his daughter to him, remained two weeks in his institution, to judge for himself. I have nowhere seen his affirmation infirmed. The renown of the professor opened for him the official schools of the mutes. Was it favor, justice, or an ambush? Let us see:

"PARIS, *April* 30, 1866.

"SIR: The 26th of October last, I authorized you to prosecute, during three months, in the Imperial Institution for the Deaf and Mute Girls of Bordeaux, the experimentation of your process of demutization, in view of its theoretical and practical value. The reports of the prefect and of the lady superior certify that you have satisfactorily accomplished your task. Your mission had for its object, first, to initiate the sisters into the intelligence and practice of your procedure; and, secondly, to teach the articulated language to a certain number of pupils. On this point, the results leave much to be desired. This new experimentation therefore corroborates the judgment passed upon your method after its trial in the Imperial Institute of Paris. It appears quite certain to say that it could endow the child born deaf with articulated language, but only after long and persevering exertions. However, the sisters appreciate the efficacy of your method, and expect from it, at no distant time, satisfactory results. Consequently I allow you an indemnity of five hundred francs, ($94.)

"The minister of the interior,

"LAVALETTE."

"BORDEAUX, *April* 8, 1871.

"SIR: My sisters believe that they understand enough of the principles of your method of demutization to apply it successfully; and if ever the circumstances bring you to Bordeaux, you will be able to judge of it yourself.

"SISTER AMBROISE FENASSE,
"*Superior.*"

So had thought the good sisters of Toulouse, to whom the indefatigable teacher had given his method and his lessons. But let us come back to the official schools. The following letter will show among what elements Fourcade had worked in Paris:

"PARIS, *June* 27, 1871.

"MY DEAR M. FOURCADE: You are fully right when you believe in the interest I feel for your labors, whose present success consoles me for the actual ill-will of our French *institutors*, in regard to the teaching of the mute to speak. Without going so far as yourself in the principle of what you call demutization, I approve of your labors, even when you oppose them to mine, in which I have unfortunately been betrayed by those whose assistance and sympathy I needed.

"L. VAÏSSE,
"*Director of the Institution of the Deaf and Mute of Paris.*"

The success upon which M. Vaïsse compliments the unfortunate Fourcade is this: In November, 1869, the prefect of Vaucluse had invited the municipal council of Avignon to employ him to create an institution for the deaf and mute. An associate offers some money to begin with. The name and the fervor of Fourcade attract more than twenty pupils, who pass brilliant examinations. M. Vaïsse writes encouragingly, but the associate, who first called him his master, an abbot too seeing money received, makes Fourcade understand that such a respectable house cannot well support the presence of a "*cabotin.*" But at least was he offered some compensation—a place, an appointment—something to live upon! Oh yes, Fourcade was sent afoot, two or three times a week, ten miles off, to sing at the chorister's desk (*lutrin*) of the chapel of St. Michael de Périgoulet. He is not yet insane, but is said to be eccentric!

CHAPTER III.

THE ANGLO-AMERICAN SCHOOL.

HISTORY; VISIBLE SPEECH; METHODS; CONCLUSION.

28. HISTORY.—The labors recently undertaken, in England, in Canada, and in the United States, to teach the mute to speak, offer as much analogy with those of M. Fourcade as the personal positions of the teachers offer contrast.

Mr. Alexander Melville Bell published his theory of "visible speech," and for it was created, at the University of London, the chair of *vocal physiology.* M. Fourcade had the misfortune to apply the same art of elocution to the teaching of the mute, where a tradition, equivalent to an inquisition, condemns the deaf to muteness. Mr. Bell had the happiness to see his son, A. Graham Bell, and several spirited ladies accomplish the same task in free countries. If Mr. Bell was the first to teach speech physiologically, M. Fourcade preceded the younger Bell and his co-laborers in the application of this new science to the art of making the mute speak. M. Fourcade had the gift; the Bells found the support. Nobody was worthier than Fourcade to be the chief of this school, new, or resuscitated from the writings of Pereire. But those who make martyrs of the original thinkers take good care to deprive them of some of their higher attributes, that they may be represented as incapable. Thus the physiological method of making the mute speak will be, in fact, if not in right, Anglo-American. Another Alsace gone!

We are obliged, therefore, to study this art where it prospers, instead of where it is hunted down. The Messrs. Bell have now no school—one on account of his age and the other on account of his health; but their writings exist, and their successors prosper. I have seen the magisterial dignity and quickness of Miss Trask, and the infinite delicacy of Miss Hull in London; but I have not yet had the opportunity to appreciate the qualties for which Miss Rogers, of Northamptom, Mass., is placed in the first rank by those who have seen her school. I will speak of what I know best.

The school of Illinois, situated at Jacksonville, is almost as old as the State; has grown with it, and has almost nothing to ask from it, but the annual subvention.

Through the efforts of the devoted Dr. Gallaudet, the school of Paris was reproduced, with improvements, in Hartford, New York, Jacksonville, and other places. The latter school is managed by Dr. Gillet, an institutor of twenty years' experience. The other officers, except the directors of the mechanical labor of the male pupils, are all ladies; for either

boys or girls, it is in the natural order. There is about one person employed for every ten pupils, and there are always more than three hundred inmates.

29. VISIBLE SPEECH.—Until 1866, Dr. Gillet had taught by the language of the signs, for which he had great talent and reputation. But the reading of the life and method of Pereire shook his faith in it, and what he saw and heard of the pupils of Miss Rogers decided him to send his best lady teacher to learn in Massachusetts the rediscovered art. Thus it sometimes happens that the smallest American States give light to the largest. Since that time, Miss Trask opens every year a class of speech for the new-comers. Though her first lessons are individual, to correct the peculiarities of each, her teaching is collective for from eight to fifteen pupils, standing in a semicircle around her, but not separated from her by anything like the oval table of the Germans. She holds, alternately, a little stick, to mark the time or duration of the sounds; an ivory fork, to softly direct the internal organs of articulation, and the chalk to draw or write as instruction requires. She also uses, very dexterously, the thumb and index-finger to form an image of the cavity of the mouth, at all the degrees of opening desired in the course of the lesson. In her first encounter with a child, she uses the means of communication employed with him at home; but after a very few days she puts those means aside, and employs simultaneously articulation, writing, reading, drawing, and teaches them by example to imitate the symbols of the "visible speech," made by herself or by the more forward children, without any admixture of manual alphabet or mimic language. The chief mode of teaching at Jacksonville, as well as in Northampton and in London, is by the "visible speech" of MM. Bell. I will try to give an idea of it.

It is represented by an alphabet, of which each letter, called a symbol, represents, at the same time, the sound to be emitted and the position of the organs of speech during its emission; the form of the letters being the very form the organs must assume to pronounce them, be the word English or Mantchou. One cannot understand it, yet one cannot pronounce it wrong; and one can read it, without knowing what it means, to another who will know its meaning. This will unavoidably happen, because the letters or symbols represent, as would drawings, the mouth in its varied speaking positions.

In this phonetic writing, the simple voices, or vocals, are represented by the straight vertical line, modified by the addition to it of subordinate symbols, which indicate the parts of the organs where the voice undergoes certain modifications to form the different vowels. When the sound must pass through the nose, that line is slightly undulated, as is the velum of the palate in this passage.

The consonants are represented by curves, not unlike the letter C, but whose positions and combinations express the meaning by showing the position to be assumed by the organs. Thus, the convexity toward the

left, as in our alphabet, represents the curve of the tongue carried backward, as in K; the same symbol, with the curve turned upward, as in Y; the same, with curve downward, point up, as in T; the same, curved forward, as in P, and so on.

Combinations of the straight and curved lines form syllables and words. There are also marks which modify a sound, (modifiers;) others which shorten it, (glides;) others to prolong it; and others, like accents, which mark the emphasis before the word or syllable to be made prominent.

In the class and class-books, opposite to these symbolic letters, there are engravings of all the corresponding positions of the external and internal organs of speech, and also our ordinary letters and syllables. The alphabet and ordinary writing are taught simultaneously with this physiological alphabet; the children learn to write and read, to pronounce and answer, at the sight of the two, or of each of those alphabets separately.

30. METHOD.—In the beginning of the instruction, one meets with great diversities of disposition, which require great perspicuity and patience in management; for if some of the children understand at once what is shown to and required from them, others are immovable, and even may fall into a taciturn apathy, from which they sometimes come out only when a ray beaming, nobody knows from whence, lights up their sensorium. But this condition of impenetrability of their sensorium to the means of education may last a long while, and even simulate idiocy. However, it is good to keep in mind, against discouraging influences, that there are no more cases of profound or true idiocy among children born deaf than among any other class of children; and that the supposed idiots pointed out are "*enfants arriérés*," or affected with very superficial idiocy; effects of the blanks left in their minds by the absence of the whole series of notions which enter the brains of other children through the auditory channel.

Nevertheless, since there is no room here for these physiological questions, the method used in Jacksonville, Northampton, and London, and which is yet in its period of development, is the most appropriate to remove the darkness of mind resulting from the privation of the auditive perceptions, and of the whole order of ideas which are derived from these perceptions. All the parts of education are taught by Dr. Gillet and his *institutresses* by speech and by writing, which are not only for the mute, as it is pretended, two distinct forms of language, but are co-relative and counterproofs one from the other. By this double process, as Miss Trask here, and Professor Vaüsse in Paris, remarked if a deaf pupil does not speak his language as well as one who hears, he writes it better than one who cannot speak it.

Large books have been written to prove that the child born deaf cannot comprehend spoken language, even when he comprehends that which is written. But, besides the mutual support which these two forms of

the same thing afford to each other in the mind, the deaf, like the hearing child, understands them both equally, by intuition, from his own procedure, and by position (given to the words) from our own. Which of us has looked in the dictionary for the meaning of a single word among a thousand? Their positions defined them to our intuition. But if we are what some teachers of the mute appear to be, the biggest books will not be sufficient to put in position, at their logical places, the words whose comprehension we want to give to the child born mute. Therein lies the logic of the method of teaching the language. Those to whom this method is not open from intuition, too, may go to see its application to the less gifted of the children in the school for idiots; and there is a very good one near by Dr. Gillet's in Jacksonville.

But I see that I have left the class-room of Miss Trask to enter into the explications of which her teaching has been the subject-matter. This being so, it may be as well to continue in the same train, after having given the reader to understand that most of the following reflections resulted from a conversation between Miss Trask, Dr. Gillet, and myself after we left the class-room.

Imitation was at first an empirical mode of teaching the mute to speak. It became also the first lever of the methods deserving that philosophical name. Thus the training by which this aptitude is strengthened in the mute must be made a mediate part of his instruction. But the short road to call the attention of the pupil at first to our organs of speech, in order to make him imitate their movements by his own, may eventually prove the longest and the least easy. For these organs of his have been previously impulsed only by unconscious movements of totality, and their internal and compact structure or mechanism allows the child to perceive but a few of the more external and extreme movements of the speaking-organs of the master. We must not forget, also, that the deaf and mute, in order to learn to speak, will need all his modalities of feeling the vibrations of the voice, and that his hand must be educated for the duty of carrying many of these vibrations to the brain, which, in its turn, will send back to the executive apparatus the order for reproducing them. Meanwhile the mouth in its turn ought to learn how to direct the most attentive operations of the touch to its own component parts, as the tongue or lips, which can exercise toward each other the functions of palpation, as the hand would do. We should remember, too, that the same tactile education is due to the temples, neck, epigastrium, and wherever the vibrations of the human voice have a chance to be perceived. For these reasons—though there are others also—it seems more advantageous to choose the apparently more circuitous, but really surer path of the manual imitations, to exercise upon at first—as on a gymnastic apparatus—the aptitude to imitate of the new pupils. Soon, indeed, a teacher cannot fail to perceive the great advantages the hand affords for these tactile exercises upon the mouth and the other vibrant parts above referred to.

The hand is more sensitive, more habituated to feel than any of the internal organs of speech; more conscious of its tactile impressions; and, above all, its parts are admirably distinct, by which disposition the slightest of their movements and contacts are rendered appreciable by the regard and by the tact. On this latter point, it would be a grave error to imagine that the deaf pupil makes valuable exercises of the hands, when he acts the manual alphabet of the language of the signs, and thereby gains some tactile experience which could be afterward transferred in his study of the speech. For the gestures and signs, after they have been learned with reflection, knowingly produced and photographed seriatim during the first scholastic impressions, will fall from the order of rational operations into that of automatism. But automatism is a function by which the act is accomplished from the periphery to a neighboring ganglion, and *vice versa*, without ascending or descending communication to and from the cephalic center. This mechanism suffices to explain altogether the incomparable rapidity and precision of the automatic operations, particularly those of the hand, but also their imperfectibility and intransferability from one organ to another. That is the reason also why the past unconscious movements of the mouth, no more than the previous hand mimics, do not prepare these organs for the conscious movements which will be needed in the exercises of speech. In this wise, the exercises of imitation are at first rational, but by routine may become automatic to the point of stultifying even an idiot. On the contrary, manual imitation carried with spirit—as we do, or ought to do, in educating idiots—is, the antipode of automatism, a lively intellectual exercise. So, when you use either the regard or the touch to make the child perceive the movements which produce speech, the exercises which promote imitation must follow each other as the unexpected words from an unknown and interesting book. In a lesson of imitation thus given and received, the impressions have to pass from the periphery to the encephalon, and from this center to the periphery by a double route along the sensitive and motor nerves. The labor of imitation is conscious, though rapid, rational, and consequently susceptible of transference. It will accordingly be possible, when convenient and opportune, to transfer this work, the produce of digital imitation, to the organs of the speech, when this transference takes place, be your agent the regard, or the touch; or both.

But let us have a short practical digression about the former. The regard has likely been the oldest and the only sense substituted for the hearing in the teaching of the articulation to deaf and dumb children. "They were taught to listen with their eyes," said the books. We have described several of the means and appliances used to that effect by several schools. But new ones will be found; and just now Dr. Lemercier, collaborator of Dr. Auzou in the manufacture of the most perfect anatomical models, called *clastics*, is prepared to produce a vertical section of the human head, natural size, in which all the pieces of anatom-

ical physiology, representing the organs of speech in the act of pronouncing each sound of the language, could be inserted. Upon this piece already executed, and by the movable pieces, to be made to order, not only the teacher will be able to leisurely demonstrate, *de visu et tactu*, the most hidden positions, but his pupils will be enabled to repeat alone at any time their exercises of speech with a better guide than the mirror of Don Lopez, the symbols of M. M. Bell, or the photographs of Professor Fourcade. For it is a fact, which everybody can ascertain, that the sight of, and the contact with, substantial models or plastic examples invite to imitation infinitely more than the regard alone, made attractive by plan-drawings or pictures. But these excellent objective instruments, and others to come no doubt, will never push aside and out of practice the *subjective* process by which the conscious touch of the mute is developed to its highest power of reflected tactility, and concentrated from the hand and periphery to the buccal cavity. This done, the pupil will be able to feel the most minute changes in the position of his organs of speech, and will soon become habituated to produce them, at first by imitation after examples or models like those of Dr. Lemercier, then on command of his master, or on challenge of his comrades, in mutual lessons, in which each pupil in his turn is master or scholar, with some hearing friend as judge; and, lastly, from his own will and spontaneity (*proprio motu*) in practical successions of voices and articulations, whose continuity and modulation will soon be the speech.

One can now understand the propriety of the expression by which I characterized imitation as the first lever of the teaching of speech. To this lever motors were needed, and they are found in the regard and touch, educated to the rank of intellectual functions. In possession of these three instruments, the deaf, absolutely dumb, will speak; that is, say what he feels, and feel what he says. For the deaf who distinguish in various degrees the voices but not the words, who have an idea of the speech but cannot imitate it by want of a sufficient auditive perception, this special sensation must be revived, as is the touch in the blind, the eye-sight in the painter, the smell in the perfumer. This is the object of a sensorial education, in which our ancestors have preceded us. Pereire extended the audition of the subjects of this third category so far that he brought some of them to the point of following a conversation without looking at the mouth of their interlocutors. With our newly-acquired knowledge, we must be capable of producing the same results without showing too much vanity.

A last remark on speech. It is the result of a complex function, spontaneously produced in ordinary children, and artificially in those born deaf. The artifice consists in developing separately, then altogether, by a sort of fusion, its elements, which are: the air expired with certain managements; the same air rendered sonorous by its passage before cords more or less tense, (vocal cords,) and under a vibratile tongue, (epiglottis;) this same sound rendered articulate in its course along a

series of organs which open, shut, redress, or flatten themselves to prepare, for one or the other issue, (mouth or nostrils,) the exit of sweet, slow, short, long, stridant, sibilant, or explosive syllables, according to the obstacles which they meet on the way. They succeeded first in making the mute speak by simple imitation of the one person by the other; then, to personal imitation, was added that of objects by the sight. This latter, by the improvement of the objects, became anatomic, and by the progress of the methods physiologic. But no great stride has been made in the use of imitation by the mute, because its training was not first made upon the external organ, like the hand, and, later, transferred to the internal ones of the speech; which is the only way to endow this function with intelligence, quickness, and precision. They have, like Pereire, l'Abbé Villa in Milan, Don Lopez in Madrid, Vaïsse in Paris, Magnat in Geneva, Fourcade at all the stations of his cross, and others in Savoy, Belgium, Switzerland, employed the manual touch, and the natural capacity of some organs for the perception of the vibrations of the voice; but I am not aware that any one since Pereire ever tried to elevate the touch of the deaf to the degree of efficacy of that of the blind, nor transferred this sense, once intellectualized, from its external and particular manual sphere of action, to the internal organs of speech. One feels that there is here a whole field to be cultivated; for the organs, components of these parts, from the diaphragm to the lips, are susceptible of a conscious touch, and of a reflective obedience to the dictates of the will. This too is to be done: the touch as well as imitation must have its special training-classes.

31. CONCLUSION.—From this review, therefore, it would be unjust to conclude that the old methods of making the mute speak were wrong; we ought to say, incomplete. Except in the period and in the country where, to erase the name of Pereire, the tradition was spirited away, this method, and the art which realizes it, have progressed by the accretion of new anthropologic discoveries.

We conclude from this rapid survey of the teaching of the deaf and mute in several countries, that the schools where they are taught no other means of communication than the gestures and writing are schools of mutism.

The French school, if it goes back to the practice of Pereire and to the first declaration of De l'Epée, will become equal to the others; and if it forces the cultivation of the tact, even unto the organs of speech, will reach the first rank.

The will of Itard ought to be respected, and his legacy faithfully applied to a normal class of speech in the school of Paris.

The schools supported by the state have for their object, not competition with, and discouragement of, private enterprises, but to test and improve their methods, and mainly to turn out competent teachers for the day-schools, like the one of the Abbé de l'Epée, or familial schools, like those of Pereire and Jankë.

Where some of the deaf children board, the school must be like a family, managed by women, and accessible to the other children, indefatigable masters of speech and of sociability. Women are, under all combinations, the best teachers, particularly of speech, and must instruct, as well as educate, the deaf children of both sexes in common.

The schools where speech is taught alone have a scientific standing. The teachings of speech, mainly characterized by imitation, or sight, or touch, do not represent exclusions, but only predominances of one procedure of teaching upon the others. By calling to their aid descriptive and plastic anatomy, and the physiology of the senses, these schools invoke mutual friends, which cannot fail to operate an early fusion of all the methods in a single and final one. Already the means employed in the various schools of speech may be characterized as physiologic, and the time cannot be far distant when, by the identity of their principles and the conformity of their teachings to the procedures of nature, they will deserve the collective appellation which Miss Hull found in her clear foresight: THE NATURAL METHOD OF INSTRUCTING AND TEACHING THE DEAF-MUTE TO SPEAK.

As I premised in the first part of this report, very few of the facts relating to *education* could be seen at Vienna. Concerning the *education of the deaf-mute*, for instance, there was only one school represented in the *Welt-Ausstellung*, the Spanish, and admirably too; but, for comparison, we had to go, not only to Paris, to Rotterdam, to Dresden, to our own Jacksonville, &c., but it was necessary also to go back in the history, even in the mysteries of the origins of these schools for deaf-mutes, in order to comprehend the philosophy of their education and the drift of the progress in the method of their instruction.

Moreover, I am aware that since the travels and studies *de visu* on which this report is founded were gone through, in 1873, several new facts may have transpired which may modify some of the details of my conclusions, or sooner open new prospects. To note only one of those of which the news has reached me: M. Eugène Pereire has called Professor Magnat from Geneva to Paris, to open a school for the teaching of the deaf-mutes to speak, in honor of Jacob Rodrigues Pereire, and it is to be as much as possible in imitation of his method. This will be a great progress for Paris, where a class of *articulation* is now intermittently set afloat to prevent the heirs of Itard from recovering the misused property bequeathed by him for a class of *speech*.

In due honor to him, Itard, my first teacher, and of J. R. Pereire, whom the intellectual guides of my youth venerated, I have concluded this second part of my report, leaving unfinished the first and unwritten the third, though its subject, the *education of idiots*, is as dear to me as the teaching of speech to the mute was to Itard and Pereire—thus paying the debt of my friends first, and trusting that the time may be spared, and the strength left me to finish the parts of this work, which I consider as my own indebtedness to truth, a pretext *à la Penelope* to live a little longer.

PART III.

EDUCATION OF IDIOTS AND OF FEEBLE-MINDED CHILDREN.

EDUCATION OF IDIOTS AND FEEBLE-MINDED CHILDREN.

CHAPTER I.

FOREIGN SCHOOLS FOR IDIOTS.

ORIGIN OF SUCH EDUCATION; GERMAN SCHOOLS; GERMAN METHODS; THE SCHOOL OF GLADBACH; BELGIAN AND DUTCH SCHOOLS; GHEEL; GHENT; THE HAGUE; FRENCH SCHOOLS AT BICÊTRE, LA SALPÊTRIÈRE, GENTILLY; ENGLISH SCHOOLS AT ESSEX HALL, EARLSWOOD, LANCASTER, NORMAN FIELD.

32. ORIGIN.—Next in order—I mean in order of special teaching—would come a survey of what was exhibited in Vienna and seen in European schools for the education of the blind. But we have seen nothing new and worthy of special encomium; on the contrary, some alterations which do not seem for the better; for instance, the limitation of their professional teaching to music in two forms—instrumental execution and tuning. Under the leadership of Dr. Howe, the blind have been better taught than that in this Republic. Being here particularly interested in the principle, we have already shown the theory of the substitution of the sense of touch for that of sight:

1st. When Pereire taught Mlle. Lemarrois, her mother, and all her family to speak and read by the touch on the arm, or in the hand of each other;

2nd. Saboureux exposing the theory of this fact and demanding its application to the teaching of the blind;

3rd. The Abbé de l'Epée advocating this idea of his acquaintance Saboureux;

4th. Long before Haüy realized it (1784)—a realization which demanded more benevolence than brains. Therefore we break the chronological order in favor of the rational order which calls for the *education of idiots and feeble-minded children.*

This education, too, was like an offshoot of that of the deaf-mutes. Not only did Itard, forty years physician in the Parisian Institution, conduct there the experimental training of the *Sauvage de l'Aveyron*, but he applied to it the same physiological ideas which, in Pereire, had received the approbation of Lecat, Rousseau, and Buffon. Happily, the period of incubation and development of this idea may be omitted here, where are wanted only the results arrived at in educating idiots.

Few of these results could be seen in the Welt-Ausstellung, but the

bulk were scattered in many schools, all created since 1840. I had before starting visited the American; so that with memory fresh from the doings at home I could see and compare what was done abroad.

33. 1.—GERMAN SCHOOLS FOR IDIOTS—METHOD.—Germany did not impress me as having made much progress; but I have not seen all her schools. Speaking only of those I visited, where I expected the best I found the worst, that is at Berlin and Dresden. I had in my mind the labors of Sagaert, and under my eyes places qualifiable only by negatives; unmedical, unclassical, hardly custodian. But Sagaert had left the direction of the school for idiots and deaf children for the more influential position of intimate counselor of the Kaiser in all matters of education. His mind was now scattered in his pupils, two of them already named, Kratz of Liegnitz, and Linartz of Aix-la-Chapelle, (Aachen.) In the German school it has been a mistake, or a necessity to be regretted, to mingle the idiots with the mutes; the former being harmed in several ways, and benefited in almost none by the often rude contact of the latter, and the teacher of both being overtaxed, and also ill-helped. For, if the state institutions are tolerably supplied with subteachers and attendants, the provincial ones are miserably provided; and with grief I left Liegnitz, where I saw Kratz working like three or four men.

I also saw the children take a meal of only a piece of dry dark bread, though cheerfully; and the building was very dilapidated, though clean and well aired, with fine open grounds. The province is poor.

The school of Crashnitz, near Breslau, is large and well provided. I did not penetrate far enough north to see it, nor those of Bendorf, Stettin, Hanover, nor the much-vaunted one of Dr. Laudenberger near Stutgard. But I saw the school of Gladbach, near Dusseldorf, whose name, written over the front gate, is HEPHATA.

This institution has existed fifteen years under the direction of Dr. Barthold, a pupil of Laudenberger—a man of ripe and confirmed ideas, which, if not entirely right, may be grasped and discussed.

The grounds are fine, the buildings have a conventual air, like our old *College d'Auxerre*, built by Amiot—minus the elegant chappelle. There are one hundred and thirty pupils—ninety boys and forty girls—taught by two male teachers, and ten females who attend to general nursing, education in cleanliness, and elementary good habits. The rooms are scantily furnished with models, charts, &c., but full of desks, and the desks full of pupils. College reminiscences again forced their way into my mind, not because we too were idiots (of some sort), but because those of Gladbach were almost as crowded as were we with books, slates, and similar instruments, which, if they do not sharpen, must dull the wit—files used the wrong way. I have seen no gymnastics, no course of muscular and sensory training, no series of acts of imitation, no manual exercises. I must have missed the exercises of speech, which cannot be omitted in a school for idiots.

Girls and boys are educated together; they live at home or with some

friend if possible, coming to the classes only, and, when capable, spending part of their time where they are apprenticed preparatory to leaving the institution. I am sorry to say that I saw no playthings. Life is not only studious, but it looks serious at Gladbach; two facts reflecting the social condition of the surrounding population. Accordingly, as soon as possible the idiots are set to work, the girls housekeeping and sewing, the boys hewing, spading, &c., in the grounds of the institution; in bad weather all making baskets, hosiery, list-shoes, &c., for the trade.

A cent is one cent, says the proverb. Absurd! It may be one dollar or an eagle. Wherever work is paid for in copper, silver is retained by the tradesman, and gold is hoarded by a landed or military aristocracy. The idiots have not yet secured the eagle, and work hard for the copper. Once earned, I believe it is applied, as far as it can go, to their comfort. However, these children look well; I could not say happy, for they look happy only when they are happy. German education may be thus summed—instruction, occupation, no training of the functions. I am aware that Sagaert, Linarts, and Krats have higher ideas; but other schools are lower than Gladbach's, which remains for me the representative of the average education for idiots. If I am mistaken, I should like to be corrected.

34. Belgian and Dutch schools for idiots.—I have seen idiots kept only in two places in Belgium. In Gheel about fifteen were set free according to the remarkable system of management of the insane in that village; and consequently, nearly every one of them is a type of individuality. One, Adrienne Jack, shows real talent for ornamentation, otherwise low in idiocy. There is not room here to describe his brother and the others. I should not be surprised to hear that Dr. Bulkens, awakened to the importance of the work, and tempted by his exceptional opportunities, has, since our conversation, organized a school for idiots on a familiar plan, somewhat analogous to the one he uses for the treatment of his 1,600 insane patients.

In Ghent, the celebrated hospital, Guislain, contains, with 470 insane inmates, 70 idiots, 30 paralytics and *gateux*, 40 who are able to go to school. The school, once organized for the insane by Guislain, resembles those founded by Leuret at Bicêtre, and Trelat at the Salpêtrière. Contemporary conceptions good for insanes, inappropriate for idiots. Thus, in the Guislain school, the idiots learn to write, read, and cipher, if they can. But there are no gymnastics, no training of the senses, no drawing lessons, none of the specific forms of education corresponding to the native incapacities of the idiot. The successor of Guislain, Dr. Ingels, is well aware of these deficiences; but what can he do when Frére Thomas says No? Change the name (which is always pseudonymous); it is the same brother who overrules Dr. Arteau, in Lyons, at the hospital of the Anticaille, and wherever, by dint of humility, he has seized a crushing power.

In Holland this pressure has been set aside, and men can do what they

think right. The exercise of this faculty has developed in this little nation a marvellous sense of the proportion to be kept between the means and the object; proportions of which their school for idiots offers a correct example; marvellous, considering the exaggeration, or the scantiness, of the means elsewhere attributed to the same end.

The institution for the education of idiots was founded at the Hague, under the patronage of the present Queen of Holland, with the concurrence of Hirsch, the great teacher of the deaf-mutes of Rotterdam, and of Schroeder von der Kolk, the physiologist, of whom the loss was so soon afterward to be lamented.

When I visited the school, it was under the judicious management of Professor Moesveld. It accommodated twenty-seven girls and forty boys of various ages, and educated them together in all grades. Twenty-five out of the whole number were day pupils, who nightly went home, but a larger number were leaving the class-rooms between lessons to spend part of their time in the shops of the neighborhood, learning a simple trade, as making cigars, mats, bottoms of chairs, &c. This is evidently the result of what may be called the *policy* of the Dutch plan of education, and can be written down the *ensemble* of the means of keeping alive the family feelings and habits in the parents, as well as in the child; of habituating the neighbors, and particularly the children, to look kindly toward the idiot; to give him habits of industry under kind supervision; to assist him first as a helpless apprentice, later as a defenseless helper; of giving confidence to the idiot, who is naturally or experimentally apprehensive of contact with wit and craftiness. They seem to consider here that the idiot loses more than he gains by bartering his family feelings and his opportunities and friendly associations in labor for a little reading, ciphering, drawing, and improved standing before a public oftener supercilious than benevolent. Accordingly, they have tried to accumulate in his favor the advantages of the school for learning, and of the family and neighborhood associations for the sake of sociability and happiness.

To obtain the moral effects of this plan, the school is situated in the center of the city; it is of easy access, and is surrounded by the laboring population, so that the children may be in and out, taught inside or at work outside, without trouble or more loss of time than is required for an airing.

The institution may be described as a collection of old, but Holland-clean, residences, connected by cheap sheds, appropriated for gymnastic exercises, of which the doors and windows open at the sun. The gardens in front have been made into one yard, well-drained and graveled; fine trees, with tops widespead like umbrellas, have been spared at a distance from the buildings. In fine weather these grounds may be made to supply room for active training and play; a compensation for the exiguity of the apartments. If the institution is not showy in its buildings, it is rich in the essentials of a school. It employs nine teachers,

male or female, besides the numerous servants for sixty-seven pupils, a part of whom only are residents. The children are treated with quiet kindness, and great pains are taken to make them write and read, and particularly speak, which seems here the touch-stone of success in educating them. The elementary notions of objects, as form, color, usage, or combination, are not neglected, but an appropriate occupation, and through it a steady habit productive of some good, is the desideratum toward which all efforts tend. Accordingly, the children are well looked for, not only in the school but out of it; not only for their present wants, but for their future position and happiness. The superintendent and his efficient (not figure-head) trustees are in direct communication with families willing to take an idiot as an apprentice, for a few hours daily at first. If the arrangements succeed, they examine the pupil, ascertain his progress, the quantity of labor exacted, and the general and moral character of his associations; and when, little by little, the ties which connect the child with the institution are naturally severed, they feel that they have not only educated their charge to the best of his and their ability, but left him in the best circumstances.

You feel this objective and this sanctification of human efforts more here than anywhere else. Visiting these institutions, each will leave on your mind its impression, which is like its *signalement;* in one you feel the motor to be the self-pride of the superior officers, in another the happiness of the children, in another a desire for theatrical effect, in another a sincere Christianity, in another a cold pressure upon the recipients of care or of alms. Here, you feel that the children are educated in the prevision of preparing them for the position which will suit them best in a society of kind realists. Epileptics are not admitted; that is practical too.

So that geography brought in close contact two very different modes of comprehending our subject. On the eastern side of the Escaut, idiots are educated as brothers and sisters, as near home as possible, and are cared for by women; and they are prepared and provided for a future commensurate to their forces and their desires in not uncongenial society. On the western side, male idiots—I have not seen the girls—are shut up, in the hope of receiving a minimum of education, which they do not, and without hope of seeing a mother's face; instead of which they see a male-keeper's. The Dutch is the common-sense system; the Belgian is called the religious and *hospitalier;* in the Hague the children are prepared to improve in this world and to enjoy a bit of it; in Ghent they are treated like innocents needing no improvement to go to heaven.

35. FRENCH SCHOOLS FOR IDIOTS.—Not only did the French open the first public school for idiots in 1841–42 at the Hospice des Incurables de la rue St. Martin, since transferred to Bicêtre, but they produced the philosophical history of the *Éducation du Sauvage de l'Aveyron* and the classical treatise on the *Traitement Moral, Hygiène et Éducation des*

Idiots—two books whose superiority, or at least whose priority, is not yet contested. How is it, then, that, with such odds in their favor, the French officials feel so nervous when they are asked for a permit to visit their schools for idiots? There was a time when, after such visits, Horace Mann and George Sumner would write home that Massachusetts could not do a minute longer without a school for idiots, and the South-Boston school was voted into existence; Sagaert, inspired by the reports of the Hôpital des Incurables, opened the school of Berlin; Prince Albert created Earlswood; Guggembul was the only one who never heard or read about Bicêtre, and behaved accordingly.

36. *School for idiotic boys at Bicêtre.*—Why, then, ashamed of that school? For a third of a century it has had the same unique teacher; the same two uniformed attendants, cape in hand; the same musicians playing as if they were deaf, though only blind; the same school-material, old benches, unique black-boards, &c.; we would almost say the same pupils, so general is the sameness. Everything is preserved as with Rip Van Winkle.

Let us look closer. There are sixty-four children; some idiots, to be sure, even *gateux;* but fifty-two epileptics. Everybody knows the difference in regard to education. Yet a visitor coming, "*En avant les épileptiques!*" (Forward, the epileptics!) It is not the fault of the teacher; it is the rule. Twenty of them play on musical instruments; they can fence, with small prospect of becoming as useful to their country as either of the Graniers (de Cassagnac.) Well, we pass on, asking for true idiots. The officials become uneasy, like their superior of the Parvis Notre Dame; they had forgotten the idiots. I do not blame the teacher personally, who has his hands more than full with the sixty-four pupils of all kinds. On the contrary, to relieve his mind, I point to a little fellow, (æt. 10,) and ask "What is the matter with him?" "A very low idiot." "Is he educated?" "Impossible!" "Imitative?" "He is not." "Move his fingers on command?" "He would not even look at you." I begged permission to bring the boy to the blackboard. Putting a piece of chalk in his hand, having one in mine, I drew a vertical line—he drew another; a horizontal one on top of the first—he put his second line in the same position; an oblique line between both of his was followed in the same direction. There was a triangle drawn by the boy who "could do nothing," and his eye had brightened, demanding more excitement. I made him imitate some movements of my fingers. For charity's sake I did not want to go further, and was about dismissing the little fellow with a pat on the head, when I saw a large patch eaten by *tinea capitis;* (witness, Eugene Dupuy, assistant to Brown Sequard). Then we understood Rip Van Winkle. He awakes, sees his rifle, wants to seize it; but, at his touch, its form disaggregates. So, in Bicêtre, we had seen the form (*imago*) of the school for idiots. All the pieces were real, but it fell apart the moment we tried to seize it. Teachers, attendants, children, objects were there together in the shape of a school; but the

cohesive idea of physiological education was no longer circulating among the parts.

This is said in justice to the philosophical idea, which, if it has dwindled to a shadow here, has become a living thing again farther on. Let me say that the children of Bicêtre—I do not say idiots, since they are mostly epileptics—are provided for at the public expense, kindly treated by their keepers, well fed by the administration, and worked moderately, though not in view of an apprenticeship. As for their teacher, M. de la Porte, his devotion to such a task, his power of keeping in coaptation the pieces of that machinery—a school for idiots minus its spirit—his uniform kindness and endurance, entitle him to credit for uncommon strength and faithfulness. Yet the dreary task must have its attraction in the fascinating hope of doing some good to the motherless idiots of the French hospitals, since the Salpêtrière will furnish a higher example of devotion to them than Bicêtre.

37. *School for idiotic girls at the Salpêtrière.*—Although there was always a number of children among the large female population of the Salpêtrière, no special school was appropriated to them, and they certainly received no special training in relation to their infirmity, till the success of the school of Bicêtre rendered unavoidable the formation of a similar one for girls at the Salpêtrière. We are not concerned with the history of this school, only with its present working and with the results as they appear to an outsider who thinks he can see through the subject.

The school is kept in a low and dilapidated building, without partitions, with windows and doors whose cracks are blessings. This mean and unique class-room is cumbered with benches and a few desks; some charts and pictures hang on the wall. There is no room for exercises of imitation, nor for co-ordinate and group movements; there is a narrow space in front of the blackboard. Children can only stand or sit—I am wrong, they can fall, too—a privilege not easily denied to epilectics; and there are twenty-five of them among the fifty pupils. The other half is composed of idiots of various grades, some afflicted with hemiplegia and other accessory infirmities.

To grapple with these anomalies, and to educate these children from the stand-point of their individual incapacity, there is one teacher. It would be more correct to say the half of one, since one-half of her time is consumed in attending the fallen epileptics, and in other cares exacted by such a medley of infirmities. I have seen her, during a short visit, twice leave a lesson to take the head of an epileptic between her knees, to protect it during the fits from being injured by striking against the furniture, and then resume teaching. For twenty-three years Mlle. Nichols has done this work, without a day's vacation, not even from sickness, at a salary of 30 francs ($6) a month. Recently, she has been given for an attendant a half-witted inmate of the hospital. After five hours in the school, her favorite topic of conversation is the improvement of

the means of educating her children. In this she sometimes succeeds by her familiar conversations and histories smartly improvised on animals, &c., and at others she blunders in the adoption of the *phonomimie*, or mimicry of letters and words, a favorite method in France, but requiring different signs for different languages, and inferior in other respects to the *visible speech* of M. Mellville Bell. But she has few opportunities of learning. No library is attached to the school; no special books are supplied, nor newspapers; visitors are more curious than learned. Her only conversation is with the physician, "chief of the service," and how far can that go? He is only visiting, not resident.

Dr. de Lassiauve would chat with the good *demoiselle* more than any of his *confrères* about the means of improving the children; he contributed to the literature of the complex subject (idiocy, epilepsy, insanity, education) several valuable books and pamphlets; but precisely because he has a mind of his own, it is easy to see, when he passes through his wards, that he is there by toleration and more spied upon than simply watched. This is made evident when, speaking of some needed reforms, he suddenly changes his voice for a whisper, and when, approached by one of the nobodies in authority, he would press the arm of his visitor and say, "I will tell you that later." I have witnessed the painful effects of this administrative terrorism over men of science in several places, as at the Anticaille, (Lyons,) and at the hospital of Charenton, where the physician made sure that two doors were shut between us and listeners before he dared speak his thoughts. Under such pressure, progress cannot flow, even; it must explode.

I heard of a convent in the south where idiots are kept; how educated? I am ignorant. And I have visited a private school for idiots, managed, under the walls of Bicêtre, by Madam and M. Baetge, who are said to have some sixty pupils. After long waiting, I was shown a few; their writing and drawing, but none of their active training, nor the general aspect of the institution—its face. It would have been interesting to compare the physiognomy of the private schools for idiots at Gentilly, France, at Normanfield, England, and at Barre, Massachusetts, not only among themselves, but with the public institutions of the same class in the same countries.

Though I am aware that these children are sent to, and received into, private schools, not on account of certain affinity or similitude in their afflictions, but because (for whatever reason) they are not educable in ordinary schools, and (for their money) are entitled to so much extra care. From this previous experience, I was prepared to not find in the charges of the Baetge family a unity of execution in schooling, nor an equality of comfort which is not bargained for. Yet, on this latter point, I expected to find the differences made by money in France far less offensive than in England, where a rich idiot makes you feel that you are his inferior: having been shown little, I have seen less.

38. ENGLISH SCHOOLS FOR IDIOTS.—These schools grew from the

initiative of Miss White, of Bath, in 1846; the article on *Idiocy* in Chambers' Edinburgh Journal, 1847; the opening of the Park House, Highgate, school by Madam Plumbe, and Drs. Gascel, Andrew Reed, and Connoly, under the presidency of Sir George Carroll, lord mayor. Money did the rest. Essex Hall, Colchester, was given; and on the corner-stone of the Earlswood Asylum £10,000 were offered. So much for English public spirit.

39. *Eastern Counties Asylum for Idiots and Imbeciles, Essex Hall, Colchester.*—There were in this asylum ninety-eight idiots—sixty-seven males and thirty-one females. Though it does not differ much in composition from other institutions of that kind—that is to say, it has about the same proportion of idiots, imbeciles, *gateux*, para- and hemi-plegics, &c.—one can feel here a kind of predominance of the motionless and aged. In this respect each institution has its own character, which the visitor feels almost from his entrance, and when entering Essex Hall one feels that it is eminently an asylum and a retreat.

This peculiarity noted, let us look at the routine, not for itself but for a few of its features. In this school they have a great deal of finger and imitation exercise, which prepares the pupils for drawing and handicraft. In the field, emulation and activity are excited by competitive weeding; and at home they stimulate the self-pride and taste of the children by competiton in the art of dressing themselves. The inmates look placidly contented, and leave the impression that their superintendent and the trustees at Colchester mean to have them so.

39. *The Earlswood school*, in Surrey, a suburb of the great metropolis, is a much more pretentious affair. In size and in number of pupils Earlswood has no equal. It has had all the advantages that money can bring to the realization of an idea; therefore, if this all but royal institution does not stand first, it is not, as with the French schools, because the idea struggled vainly against penuries and oppressions, endeavoring to come out from its immateriality into the world of substance; it was because the idea was yet immature among the English when their purse and will were, as usual, ready. They had determined to have the largest institution for idiots, and they have it; to build a monumental school, and here it stands, ample and erect, though gothic. So much for an external antithesis to Bicêtre and the Salpêtrière; but inwardly the oldest have the advantage of having furnished the young institution their worst models. Like Bicêtre, Earlswood is managed by *commis*—the physician subordinate, the teachers subdued—a machine run by men-power, instead of an organization resting on woman's tenderness and quick perceptions, and philosophically directed by one familiar with the latest investigations of anthropology.

Even though wishing to do so, I could not give an exposition of the course of training in all the schools for idiots; but I can, for each, map out, as being done or neglected, certain points in their mode of education which will, in due course of this survey, appear like the summits

of the surveyed ground. According to this plan—which may have no other merit than its necessity—I have already brought into prominence some features of the method, and I will exhibit two more about the mode and matter of the teaching at Earlswood.

Modus docendi.—In a class of about sixty young pupils, reading was taught to a few in the front, while in the rear sat the greater number, slate in hand, with orders to copy a model letter set before them.

Let us first premise that they were a well grouped set of low, though educable idiots—such a group as could only be formed out of a large collection, and by a judge, probably the physician-in-chief, who was absent during my visit. The moment that I saw them, a series of questions arose in my mind: Was it possible for these children to draw that letter: first, at such a distance from the model; second, at a greater distance from the master; third, on a slate resting on the knees; fourth, with a pencil hardly leaving a trace on a surface slippery from long use; fifth, by a hand unsteady—*a*, for want of previous exercise, *b* more on account of mental uncertainty in comprehension, and *c* by the novelty of the sensations attending such a reasoned operation after having lived so long in nihilism, and acted by pure automatism? The answer to all these questions was on the slates. They were covered with wandering lines, hardly visible, whose character—where any could be distinguished—was a tendency to re enter at various angles the center of the plane, after a meandering in what we shall call curves simply because they were not straight. Indeed, nothing could be more expressive of the uncertainty of the hand and of the mind than these, at first sight, unmeaning lines; for they spoke eloquently. At this point of the teaching, the teacher must be close by the pupil; his hand must move in the desired direction, to make the idiot's hand move likewise, as if it were its shadow; the plane, besides being steady, must present itself almost unavoidably to the unfixed gaze; the pencil must easily leave a strong delineation; the lines demanded must be simple, and their succession in accordance with the natural order of their generation on the plan. Every one of these conditions of success—let us say more—of these elements of teaching idiots drawing and writing, was scrupulously avoided in Earlswood. Singularly enough, they were blundering at the point where the teacher of Bicêtre thought nothing could be attempted, so that, at this dividing line which separates *routine teaching* from *physiological training*, the English could not see the line; the Frenchman felt it, and knew that he did not know enough to cross it.

A matter of great interest taught at Earlswood, but not exclusively, for I have seen it in the Pennsylvania training-school for feéble-minded children, managed by Dr. Kerlin, is the *teaching of buying and selling* in a store-class-room, where the children are alternately buyers and sellers. In the New York State School for Idiots there is not such formal teaching, but the children who can do so are sent into town to make small purchases, in order to exercise their judgment in regard to the money-

value of things. This teaching is rendered the more necessary as the institutions for idiots become larger and more separated from the world. For, if the street-abandoned idiot, or the one cared for, but uneducated at home, or the one free in his movements between school-hours, is left liable to do wrong and to be wronged, he meets, as a compensation, with opportunities of witnessing many unenarrable human relations, and particularly of comprehending the commercial character of social transactions, beginning, if you please, with the small opportunity of exchanging candy or chestnuts for a penny. But the idiot, shut up in the center of a perfectly organized, self-feeding machine, has no opportunity of conceiving the reciprocities of life; he cannot help feeling that the world—the only world he knows—is made for him, and that it is for him to receive without reciprocally rendering compensation; hence he is, when growing, deprived by a providence of the feeling on which hinged morality; and, when grown up, his egotized countenance deprives him of a good deal of legitimate sympathy.

Another fault of large institutions is training children for show in two ways: In each group or class of idiots are inserted some almost ordinary children, epileptic, choreic, or hemiplegic, who are pushed forward at the expense of the time and skill which should be devoted to the mass of *bona-fide* idiots. The spurious ones answer, for the rest, to arduous questions. But even this concession—of which I have seen no trace in the school of Surrey, though I have of the next—does not satisfy the craving of the *plebe* of visitors for something wonderful; they must be served by idiots with sauces musical, arithmetical, architecturesque, &c. With more money, and time stolen from the legitimate training of all the pupils, it is easy to find among them some with a gift salient over the wreck of the other faculties, and to set them up as the great attraction for idlers and a living prospectus for the school. They are, and will be, nothing else. The gift thus developed, at the expense of their general training, will never serve the gifted; it can but be wondered at, and they the more pitied for it. This evil practice is not confined to Earlswood; other schools for idiots have their pet mathematicians, &c., who are good for nothing; and ordinary schools and universities too often cultivate these unhealthy products. In the famed colleges of France a gifted lad, once used for show at the annual *grand concours*, is used up for life; that is not education, but crowned holocaust.

40. *Lancaster school.*—The Lancaster institution was hardly finished when I visited it in 1873. It is built on a scale which recalls to the mind that of Columbus, Ohio. Like that, it is richly endowed with money, and with pleasure and farming grounds; unlike that, this is erected and endowed by private citizens, M. DeVitrey at their head, who, like true English gentry, believe in self, and do not beg from a communistic government. These fine buildings contain about three hundred pupils, and may accommodate six hundred. The school has a physician for its chief, and a large body of female teachers and attendants,

as in America. The teaching does not differ much from ours, although it is yet more scholastic in form. The director, Dr. Shuttleworth, seems determined to carry it strictly on the physiological plan. I think he will partially succeed, though there are difficulties in his way; I mean doctrinal ones; for instance, in Lancaster, as in other parts of England, they do not seem to attach sufficient importance to that period of the education which corresponds with the idiot, to that which I will venture to call the *building mania* in the infancy of peoples. If we can make the pupil enter upon this period, and if we suscitate that taste in him, he may, through it, be carried to the conception of higher combinations of parts to form a whole, besides acquiring, in various attitudes, operations and manipulations of the material, the physical aptitudes comprehended in the word dexterity.

At the threshold of the school proper, they do not seem to understand that filiation, and therefore that rational progression, which gives precedence to the systematic movements of the body—early concentrated in the hand—over drawing, of drawing over writing, of writing over reading; that is almost the reverse order which obtains, unless, as in the majority of instances, there is no order at all, either practiced or suspected. So much for the innocence of the teacher of *innocents*, (name of the idiots in the Alps; also, *chrétiens*, *cretins*.)

A more immovable obstacle to the plans of the young and capable superintendent are the English customs which stand on the way like dolmen. At first glance, I could see that one of them was incorporated in the new building, in the shape of a magnificent dining-room for a thousand people, or so. From the gallery above, it looked like a sea, whose undulating billows were figured by the alternate benches and tables; when the three hundred pupils came and sat close together, they darkened only a small square of this area. All was orderly and neat along these long rows; but how could the children enjoy such automatic eating otherwise than by the sensation of filling up? What idiots desire as much, and need more than ourselves, is to take their meals *around* a round, or, better, an oval, table, grouped by affinities, their attendant acting the part of the mother, and the best (in both senses) pupils helping the helpless, thereby giving to themselves and to others a tangible example of practical morality; instead of this, the fine hall becomes that communistic manger which it is in many celebrated colleges.

41. *Norman-Field school.*—England looks nowhere more proud than in her littlenesses and infirmities; when she is great, her grandeur does not need padding. The pride here referred to is well illustrated by the sumptuousness of her retreats for the insane of *blood*, and her school for idiots *pure-sang*. The institution of Norman Field is a model of its kind. It has the other merit of being managed by one of those rare men who have taken hold of the subject of idiocy in some of its relations to anatomo-physiology. Its proprietor, when at the head of Earls-

wood, made extensive researches on the malformation of the mouth of idiots, and has since embodied them in a valuable book. MM. Th. Ballard and Callaway claim for themselves and for Connolly the priority of such observations, and of the demonstration of the arrest of development of the sphenoid in idiots, &c.; and Bourneville, in his *Memoire* on the condition of the mouth of idiots, quotes twenty passages from the French book, *Traitement moral, hygiène et éducation, des idiots* (Paris, 1846); and says (page 7) that "Langdon Down could claim the priority, if Seguin had not preceded him by more than fifteen years." Seguin knows by experience how often number two forgets the name of number one, expresses his approbation of the work of Down so far as it goes, and hopes that its author, being now at the head of an institution where money is plenty, and individual observation possible, will soon be able to complete his work by applying his anatomical researches and mensurations, 1st, to the practical teaching of speech to idiots; 2d, to the correction of the defects, imperfections, and difficulties of speech met with in ordinary schools. For this complementary labor, Norman Field is the place, and Dr. Langdon Down seems to be the man. The last is the first, when he does best.

CHAPTER II.

AMERICAN SCHOOLS FOR IDIOTS.

AMERICAN SCHOOLS NEARER THE IDEAL—THE SCHOOLS AT BARRE, SYRACUSE, MEDIA, COLUMBUS, AND FRANKFORT—PROMINENT POINTS OF TRAINING AND THEIR APPLICATION—CONCLUSIONS.

We shall not find the American schools for idiots as large as the English, but they are more numerous; their buildings and grounds are as fine and large in proportion; their teaching is much more feminine—that is to say, gentle, breeding more gentleness in the pupils. In details they bear a comparison, which we will begin by contrasting the oldest American private institution with the latest English school just noted.

42. *Barre school.*—Barre is an old New England scattered village, and its institution for idiots is a collection of well-appointed buildings, some on the grass, others under the trees, or basking in the sun. The main structure looks from its pillared stoop over a large shallow basin of flowers, bordered with turf, and guarded by broad edges and lanceolate evergreens. Houses and cottages are situated on the undulations of a healthy plateau, with a *sans façon* indicative of a family affair. How different from the stately mansion of Norman Field, where everything is reduced to a unity, and all, even idiocy, looks proud.

According to my comprehension of a private institution, several buildings are more favorable than one to improve the condition of the pupils. In this almost cottage-like arrangement the children who come for a home find an apartment and a kind woman, who, to a degree, keeps house for one, two, or three of them, while those more seriously crippled sleep and live in the main building, under the personal care of Madam Brown, who hears and comprehends their noises, and sees to their wants. Those belonging in these two categories are thirty-four strong; and those who come to the school for education, thirty-six boys and girls, live more or less privately, and are educated more or less individually, according to their wants and to their means, by twelve men and thirty-eight lady teachers or women assistants. This force is the wealth of the place, and with it the immobile may be moved, if humanly possible.

This school, the first in America, was opened by Dr. H. B. Wilbur, July, 1848. Soon Boston had her school; Wilbur founded the New York State Asylum for Idiots; other States followed; so that, if England has the largest, this Republic has the greatest number of well-appointed schools for idiots. Their description, however pleasant it would be to

offer it here, is aside from our object. I have only to mention some of them when their methods of training can elucidate interesting points of pedagogy.

43. *New York State Asylum for Idiots.*—This asylum, so called, really a school, is a contrast to that at Barre. This, at Syracuse, being largely supported by the State, makes no difference between the pupils on account of their pecuniary position, but groups them according to the requirements of their incapacity. Here the compactness of the building corresponds with the unity of plan of the institution, and its interior divisions to the forms of training; so that its architecture is like a glossary of the methods. In this respect, this creation—without precedent—of the mind of Wilbur is the more remarkable that *contre-sens* of stone offend the common sense (*sens commun*) all around. When children of our time are encased in a gothic castle to learn their duties for to-morrow, beware of some anachronistic monstrosity in their training. The idiots have, to some extent, escaped this danger in this country, where the Barre and Syracuse institutions represent two classes, if not two systems, of physiological training.

It was empirically admitted that some idiots can be better improved by general training, (a kind of attraction in groups,) and some by individual training, (a kind of incubation, if I may call it so.) The fitness of either process, exclusively applied, or its preponderance in the educational process, may be deduced from the observation of special cases, and in doubtful ones a trial of both methods may be resorted to, to determine which will do best. But experience has shown that, aside from rare peculiarities, among the laboring-classes—who know of civilization only by its hardships and sufferings—idiocy is found in its simplest and most easily recognized forms, sthenic and æsthenic, and therefore the more amenable to the influence of a general training, as the one mostly given in a State charitable institution; whereas, among the wealthier classes, idiocy and imbecility—being the result of multitudinous causes, mostly of sympathetic impressions bearing (by reflex action, says the language of the day; by direct action, I would say) on the womb and its modes of nutrition in pregnancy—present much more varied intrinsic characters, are frequently aggravated by accessory diseases, and also muddled among semi-capacities and disordered instincts, and they therefore are represented by these heterogeneous cases which can be favorably modified, if at all, by individual culture. Though this is one of the most interesting parts of our inquiry on the methods of education, we must only refer to the examples furnished by the private schools of Dr. Langdon Down and of Dr. Geo. Brown, of Barre, or to some old monographs like the *Résumé de ce que nous avons fait pendant quatorze mois.* (Esquirol and Seguin, Paris, 1839.)

Now hastening to gather, on our way, a few of the features of the general training of idiots which have been brought to such precision as to be ready for admittance in the general training of ordinary children,

we will—without saying a parting *adieu* to Syracuse—inspect some other schools for idiots.

44. *Pennsylvania training-school.*—In Media, the Pennsylvania training-school presents a fine specimen of training, or *entrainement*, as the French have it. About sixty children, I should judge, geometrically posted and isolated, execute movements timed by the piano or by their own songs, and indicated by a monitor whose indicator-pole passes from one to another of the diagramatic representations of exercises painted on the large frieze around the music-hall. For a person unfamiliar with the suddenness of the contagion of example on the imitative faculties, it is perfectly incomprehensible how these idiots, a moment ago limp in their postures and movements, now assume attitudes and develop poses which artists would not disdain. Yet these harmonies are as physiological as their previous awkwardness; the latter resulting from the absence of inward stimulus, the former produced by a sympathy of peripheric origin; idiots, as we call them, before and above being idiots, are men, that is, individuals capable of being sympathetically connected with their kin; the link is to be found—that is the key to their education—through the general training.

45. *Ohio State training-school.*—In the Ohio State institution for idiots at Columbus may be seen fine illustrations of the same training applied to the hand. We say the same training, because it arrives at the same results of totality, *d'ensemble*, but different in its *processi*. For before the hand can be trained in general imitation-exercises—please keep in mind the clumsy and inflexible hand of the idiot—it must receive an individual and patient training of its totality and of its several parts. These hand-movements not proceeding almost exclusively from the spine as do those of totality of the body, which are so well executed in Media, but being the result, first, of a delicate sensory perception; secondly, of a localized volition; and thirdly, of a controlling muscular sense, (leaving in the shade some intermediate agencies,) become more and more sensory and intellectual operations, in which the muscles become more and more subordinate, till a single phalanx of a finger cannot be moved without the previous exercise of the higher faculties; and groups of children cannot imitate the smallest movement of the hand of the teacher without a concurrence of volitions and neurosies—which is human electricity in action. Let us give to this explanation of a beautiful training the benefit of its demonstration by what is done with the idiotic hand.

46. SOME POINTS OF THE TRAINING OF IDIOTS.—The idiotic hand is as idiotic as the brain, since the functions of the peripheric nerves are as much affected as those of the center.

When a child begins to imitate movements of totality, the teacher sets him apart to make him imitate those of the arm, wrist, fingers, &c., simple and slow at first, then rapid and complicated. When two children have been evenly drilled in these movements, a third slower one may

be inserted into the exercise and be carried (*entrainé*) by the swiftness of perception and the volition of his flank-mates; several such groups being brought together (*rapprochés*) are formed in front of the teacher, either in a gentle curve or in two or three rows, and exercised in all the details of the most minute and most difficult movements of the hand. When the nervous strain on the children becomes evident, the exercise may be transformed into one of larger movements, which require almost no attention, and occupy them without fatigue. It is said of billiard-players and of fencers that they must use the cue and the foil every day; these children, also, under training, ought to have their hands daily exercised; and, as in some schools every course begins and ends with prayers, I would suggest frequent hand exercises, in which the powers of perception, volition, and execution would be drilled to their utmost rapidity and precision. But if the teacher command these exercises without inspiration, and as flowing from him by routine, they would in the same ratio be routine work in the pupils, melting their higher faculties in a deliquescent automatism: then prayers would do just as well.

The best lessons are not always directly given; for instance, none are likely to be more profitable than those offered by the *entrainement* of pleasure to promote activity, and even spontaneity in sluggish and passive natures. This advantage, having been early appreciated, was made one of the levers of the training. Let us see how it touched and awakened the man in the idiot. But pleasure being protean, some of its forms touched him more than others.

Few idiots are more than passively sensible to music, though exceptionally its impression on them may be said calming or exciting, and in rarer cases to have awakened melodious affinities, even in children deprived of the faculty of speech. As for the general impression made by school-music on these children, it depends upon their melody more than on their composition. The tunes may not be appropriate, as certainly some, for us very fine, left no imprint on the features of the children; and others, flat for us, elated them. But why should they not have a different sensorium of harmony than we? Each race has; nay, every class in a community. The other doubt refers to the instrument selected. The piano may not correspond to the want of such institutions, (except to keep up the time in marching, &c.) Thousands strike its ivory keys without touching the soul or sympathetic plexus, through the auditory nerve; a complicated machinery, a magic hand makes it harmonious; under ordinary fingers, it renders stroke for stroke, or, like the mule, kick for kick. However, taking a utilitarian view of music *as it is*, it does good service in the classes of instruction in voice and speech, in the gymnasium, in the imitation rooms, and in the next exercise.

By a sort of contradiction not unfrequently met with in more complete organizations, the idiot, ordinarily prone to immobility, is delighted at the sight of the movements of other people, and is often himself carried

into this movement. This is noticeable where dancing is made an habitual feature of the evenings, as, for instance, in the Ohio State Asylum at Columbus. Madam Doran—who, with her husband, created that institution, after having been a distinguished teacher in Syracuse—comprehending the importance of this lever to spontaneous activity, leads the ball, bringing into the whirlwind the timid and the weak, choosing the boy for the girl and the girl for the boy, the active for the indolent, inciting with her spirit at least two hundred motionless children to move harmoniously and contentedly.

Idiots are, if possible, more fond of the pleasures of sight. Bright colors and well-chosen contrasts affect them, and affect them quickly and rationally too; and they often bring an intelligent happiness to the surface of their pre-indifference. This action on the mind through the retina is most apparent around the Christmas-tree of the asylum at Syracuse. It is, of course, an elaborate affair. Parents have sent boxes full of presents, not only to their children, but to the children who have no parents. For a week teachers and lady friends have given their spare hours to the adornment of the tree, which covers and fills the upper part of an immense room with hundreds of playthings, and several thousand images, candies, glass balls, mirrors, and innumerable little colored-wax candles. When the branches are so loaded that they would break if not of still-living pine, an afternoon is employed to set it ablaze, and the children, issuing from a comparatively dark room, are suddenly exposed to the glare and temptation of this fruition of brightness. At this sight, hardly one face out of fifty looks idiotic during the long process of distributing so many treasures—for each child receives several. What a lesson for the eye and for the heart! On the spot, Sarah Gray, an hydrocephal, who for years could sit but not stand, and afterward could stand but could not walk, now glides silently along, erect, and looking as if loaded with her large ivory forehead, approaches a younger and weaker child, kisses her, and gives her her Christmas present. Who will say that the noble girls who spend their lives—as, for example, Miss Young at Syracuse, for twenty-three years—in educating idiots, lose their time?

Yet that noble occupation of making idiots happy has sometimes been condemned as in bad taste. In the experimental school for idiots, at Germantown, Pa., a child about twelve years old would in the evening stand on a table surrounded by a family of idiots, and, dressed for the occasion, would represent, with comical voice and gestures, some fable or story in which children and beasts would play the most absurd parts It was delightful and instructive to see idiots accept the impossibilities of the situations, and through the conventionalities of a juvenile and colored language pick up and enjoy the zest and spirit of the scenes. But they were scenes of confusion, in which the pupils became clamorous for joy, and would rise from their seats to applaud the actor; the suppression of innocent recreation restored the school to order, and the scholars, lively for once, to the dullness of idiocy.

Physiological development cannot take place without a stimulus, acting like a ferment on dormant material; the healthiest of which is not, either human or supernatural pressure, but expanding sympathy. But sympathetic feelings themselves, like the sensitive mimosa, grow only where there is no compression. The more strictly disciplined—officially speaking—the school, the less sympathy among the children, in the children toward the world, in the world toward these children of its follies, vices, and crimes. In this respect, stately institutions receive lessons from less pretending ones, where the doctor is the patriarch, his wife the main executive hand, and his daughters the teaching hands of the family-like school. Such is the one situated at the capital of Kentucky, a fine building among old trees, rich blue-grass, and stalwart corn. There, the greatest freedom of action does not destroy true discipline; the school is orderly, but lasts less, and the field-life more. A child passes from his class to the doctor's apartment without feeling the difference—at home in both, which are one to him. One of them entered the parlor in my presence, put his boots on the sofa, and placed his head at the window to see some passing sight. No reprimand followed, but, when the child had gone as he came, happy and unconscious of having done any harm, Dr. Blake told me, "If I make them fear, I will deprive them of their free will, which is more valuable than the possession of the alphabet." Thus the sympathies are gained, and the truthfulness of children who, being without fear, carry their good-will on their faces, is secured.

We never comprehended these institutions as being only for the benefit of idiots; but like hospitals existing not only for the cure of the sick, but for the progress of the art of curing and of anthropology, we considered the school for idiots as a place to test, on the most inferior children, the most natural methods of education at large—as the test-laboratory of homo-culture. Here, searching them mainly for these philosophical discoveries, we have given an imperfect idea of some of them, and have not even named others, as those of South Boston, Mass., Lakeville, Conn., Jacksonville, Ill.; but we have hardly time for a few more generalities before re-entering our principal subject, Physiological Education, loaded with the precious materials found in these special schools.

47. Conclusions.—As we have found the institutions for the deaf-mute hardly up to the physiological discoveries of J. R. Pereire, and to the suggestions of Itard, so, taking in their *ensemble* the institutions for idiots, we find them fulfilling their human object, but hardly up to their scientific design. However, knowing that the reality never completely fulfills the ideal; for a man to see what an idea penciled in his brain less than forty years ago has come to be in substance, monuments, hundreds of executors, millions expended, thousands helped, a whole world, makes him feel as does the author of *The Last Judgment*—stooping, unknown, in a corner of his own picture, listening.

Thus the amount of good done within thirty-odd years to this class of unfortunates—previously without social providence—is incalculable.

The American idea of the better fitness of women than of men to educate children received an irrefutable demonstration from its adaptation to the work of training idiots. In this, Syracuse was the normal school where the others came to learn—even the European.

The advantage of large institutions for the classification of the pupils, for their general *entrainement* in group and general exercises, for the prosecution of scientific inquiries, hardly compensates for the consequences of the sequestration of the pupils from the world, its habits, manners, and dealings.

The asylums, or schools, for idiots of England and America are models of architecture in their kind; their grounds would satisfy the pride of princes; and their retinue of physicians, teachers, attendants, surpasses in number, and probably in special knowledge, that of any other body of children trained in higher mental conditions.

On the other hand, it is enough to enter the rooms to be able to judge of the methods used in them. As, when looking at a brand-new college, we see it ogival or renaissance, and crowned with machicolations, we may be sure its curriculum is a tissue of anachronisms; so, and more, when entering a school for idiots you find the rooms filled with a sufficient number of desks, books, and charts to accommodate a Sorbonne, you know that the aim is to teach them as many letters and figures as possible, and to be quiet.

In the best of these schools, classical learning from books is partly superseded by the learning from nature. It is a progress, the essence and bearing of which are very little understood. In illustration of the confusion prevailing at this point, many teachers educate their pupils by the system called that of *object-lessons*, who are persuaded that in so doing they follow the physiological method; but it is a delusion. Undoubtedly lessons on objects are given in the course of physiological education, but as a sequence, and even as a posterior application of the method, objects being mainly called in requisition to test the two premises of the physiological method, which are (*a*) to exercise the organs to develop the functions, and (*b*) to train the functions to develop the organs. I am not convinced that this physiological method, now so much spoken of, is applied but very imperfectly in its most important departments of language, of standing and working, of the special senses, of the hand in particular.

In exercising the functions, the modes of activity which bring on a social or economical result must always, when accessible, be preferred to those which bring no products; and education, in its largest acceptation, must take, as soon as possible, a practical and productive turn.

Lastly, if sympathy is the physiological corner-stone of morality, the education of idiots founded upon it gives its finest results where the children are most loved; expansion doing what compression cannot accomplish.

This rapid survey does not do justice to the institutions for idiots, but

we could not be just with them, as we have hardly time to give prominence to the elements of physiological education scattered through them, and to show the adaptability of these principles to general education. The same remarks obtain for the two following criticisms of these institutions, expressed as much to invite an improvement as to support our thesis.

There is a dead-weight impending over these educational institutions, which is sure to fall *(incumb)* upon them as by the law of gravity. It is the continuation of the care of the pupils, when they are not claimed by trusty friends, after their school-years are over. Some institutions have foreseen that contingency, and have provided for it, (as the Pennsylvania Training-School;) others have been surprised, unprepared by the heaviness of the growing burden, (as the New York Asylum.) As this weight increases with years the younger institutions will have to face the question—not a very easy one. As regards philanthropy, it is no problem, it is a necessity, not to abandon these human beings after having supported them; but, as regards education, in view of the progress of the younger idiots, and above all, in view of the progress of the methods of education, the question is, will this dead-weight of old idiots smother the young physiological school practically or doctrinally; or can it be applied—let us say by analogy, like the weight to the motion of the pit—as a motor intermediate between the children and the formal teachers? At this point the problem is full of interest. Children sometimes will do *with* or *for* one whom they consider their equal, what they cannot or will not, or will and cannot, do under the pressure of a superior's command. They will better learn to look at things from one of their own size, whose eye consequently looks at the same angle as their own; and they will likewise be better invited to listen by a juvenile or feminine, than by a masculine voice, as nearest to their own. This brings on the no less important question of having children of other schools sent—as a reward of their good conduct—to play with the idiots, in view of teaching the latter good manners and social habits, and to give bright children a practical lesson of morality and humanity; for it cannot be denied that by shutting the idiots among themselves, even the most improved are stamped, as in a compressed mold, with a general character of polished idiocy created by the absence of higher and more varied types in shut-up schools. This question is coming home to the public schools, colleges, seminaries, as to the institutions for idiots and deaf-mutes, because isolated anomalies produce in a short time, as it is well known, specific genera; and the genus *homo* is difficult enough to educate.

The other question—no less general, though directly raised about the pedagogic of special infirmities—is, why are the teachers of idiots, &c., not encouraged to step out of their routine, to visit other institutions, to commute among themselves in view of bringing in and out of each institution their best procedures, appliances, &c.? It would be for

them almost as good as a vacation, and for their field of work as good as an intellectual fertilizer. This interchange of living forces and ideas is retarded by those who believe themselves possessed of a superior method of education—as if *methods* were as plentiful as blackberries—and want to keep it a secret for themselves. But the method of educating these children is in print comprehended in few words: *training the senses to reach the mind;* once promulgated, it belongs to all; it is improved mainly by the teachers, who ought to be rewarded, and promoted for each of their improvements; but to make a secret of doing best a known thing, pshaw! There are only two secrets in our time: one of doing openly better than others, and the other—Punchinello's.

In bringing out in relief these points of special education we had principally in view to show that the principles and origins of a *Natural Education*—whose traces are hardly discernible in schools, colleges, and educational exhibitions—can be found *passim* in the schools for deaf-mutes and idiots, ready for application to the education of all our children. From this demonstration, whose consequences we presently will follow up, results another: that if society, particularly in England and America, has been generous toward helpless children beyond all historical precedents, these children have returned to society a present a hundred-fold more valuable, in the shape of the *a-fortiori* demonstration upon themselves of the possibility of educating all the children by a physiological method.

PART IV.

GENERAL EDUCATION.

7 ED

GENERAL EDUCATION.

CHAPTER I.

THE SCHOOL AS IT IS AND AS IT SHOULD BE.

English schools; American, Swedish, Swiss, Italian, Portuguese, Austrian, Prussian, Belgian, and French schools; School-exhibits at Vienna; Interior arrangements; Furniture; Apparatus; Books.

48. In the preceding part of this report we could rarely refer to the objects exhibited in the Welt-Ausstellung, and had to borrow most of our examples from outside. But now these objects are in such quantity and variety that it is almost impossible to make a choice among them unless with a *criterium*. It is asserted that soldiers are made for the army; could we say that the child is made for the school, the proposition would seem so monstrous that we instantly would reverse it and say, *the school ought to be made for the child*. We therefore take this for the *criterium* by which all the improvements in the *matériel* of the school must be appreciated.

English education was represented only by the appliances, books, hymns, and by the music of Sunday-schools and Bible-classes. Why? Mr. Gladstone has just answered that question at Hawarden in an address on mental culture:

"In Germany, France, and in many parts of Italy, there is a much greater disposition among the people of the country to avail themselves of opportunities of knowledge and mental culture than in England. The mass of the English people is only just coming into possession of the blessing of a popular system of education," &c.

49. American popular education was represented at Vienna by a model of a complete Massachusetts school—whose fitness, considered as unique a few years ago, has now rivals worth comparing with it—and by the remarkable collection of books and charts of the American Geographical Society.

50. The Swedish school, in which attendance is compulsory for all children from seven to fourteen years, was represented by a model house or room capable of accommodating twenty girls and as many boys. A gymnasium is attached to it. It is less crowded with seats and desks than the American, and infinitely less than the French class-rooms. There is a supply of fresh water for the pupils in the entrance-hall, and another on the desk of the teacher. This desk stands higher than those of the children. At its right is a piano or organ, at the left a

table for experimental demonstrations in physics, &c., the three pieces being of plain white wood of a simple and strong pattern. The forty desks and seats are worth noting. By ingenious and strong mechanisms, the former, slightly concave in front, slides nearer the pupil when he wants to write, and the latter can be raised or lowered to suit the size of the pupil, but it does not afford any support to his back. Both are like imperfect renderings of the ideas of Liebright, of which more will be said presently. The walls are not allowed to remain unutilized. That back of the teacher (facing the scholars) is covered with a blackboard headed by model letters, of which the counterparts may be found printed in cards contained in boxes below. The upper part of this wall is occupied by changeable tableaux of music, arithmetic, geometry, and writing-models. The wall in which are three large windows is thickly trophied with rifles, trumpets, drums, and the more pacific instruments of music, and surmounted by large geographical cards. On the opposite side are tastefully grouped spades, rakes, and other implements of labor; near by, in glass cabinets, are specimens of corn, wheat, barley, flour, of plants, barks, &c., and in the next case are specimens of mineralogy and imitations of the principal forms of crystallization. The fourth side-wall supports one case containing specimens of animals, birds, insects, and reptiles, and another of objects and of physical apparatus. The lower parts contain small and large drawers, in which are series of astronomic and geological charts. One of these series is painted in black, and the children put in the right places little cubes on which the names of these places are printed; there were also geometrical drawings by the pupils, an immense variety of handiwork made by girls and boys, and particularly worthy of praise—pictures of fishes which could be equaled only in the schools of Norway and Finland. "*Ces peuples seuls comprennent le poisson.*" In other words, to comprehend the nature of the fish, it seems necessary to live almost exclusively with it, like it, upon it! The Norwegian and Finspong schools do not differ much from the Swedish. One thing is surprising, however, in the Finspong: it is the presence of the two arrangements invented in 1843 at Bicêtre to fix the *regard* of idiots who cannot direct their eye; but ideas percolate more subtly than quicksilver.

51. The Swiss schools resemble the Swedish in their closely practical aim. They may teach music more thoroughly, and physical exercise less by plain work and more by collective gymnastics, like the Germans; but they intermingle both, in a kind of general training which was planned in 1810, and has since played an important part in the unification of national characters and national movements. The influence of this part of education must be studied by all thoughtful persons and adapted to their system of training the youth, with the modifications demanded by national idiosyncrasies. In the Swiss school the chant presents itself in three modes: the infantile, which begins almost with the teaching of speech by childish rhythms and choruses; the gym-

nastic songs, incentive to the development of the chest and to the force and precision of general evolutions; of the latter there are exhibited several manuscript and printed volumes; the third form of music-teaching is to teach to large groups those popular songs found, not only in print, but in the throat and ear of everybody, and running, warming the common feelings, through the nation, as the blood runs and distributes a normal temperature throughout the individual body.

Where Agassiz, Lyell, de Beaumont, Larive, (of Geneva,) Hebert, (of the Paris normal school,) de Candole, have studied or professed, and where the Alps rise like an unavoidable text-book, it was to be expected that geology would occupy its natural place in the school. Accordingly, besides excellent elementary treatises, they have geological sections, represented in colored glass by Professor Mulberg of Arau, (Argovia.) There were seen also large collections of anthomology, of mineralogy, and illustrated scientific publications adapted to school use. History in particular is written in vast collections of images and picture-books, and the national education of the country is told in statistical, historical, cantonal, and federal records, not unlike the celebrated reports of Guizot, Cousin, Villemain, and Salvandi on French education from 1830 to 1848.

52. In Italy, where the clergy had the entire management of education, seventy-six unalphabetic were found against twenty-four people who could read; they had been taught the rosary instead of the alphabet; yet, at the first awakening of the Italians as a nation, their natural propensities showed themselves by leading the van of education toward the achievements of their forefathers: Glass-ceramique in Venice, mosaic in Rome, statuary in Florence, painting everywhere; even the great art of Vesalius and Morgani seemed to resuscitate in the admirable preparations of zootomy by Saggio and others. The schools best represented in the Welt-Ausstellung were those of Pistoia, for elementary drawing; of Perugia, for painting on vases; of Cagliari, for ornaments in black and white; of Udine, for camaien or *grisaille;* of Ravenna, for oil-painting; of Asti, for topographic charts. The most showy result of this new departure—besides the immovable mosaics left at home—is a people of statues, in which no other nation excels the Italians in naturalness. This is because, besides possessing their elegance and true force of movement, they are sincere—that is, their figures do what they pretend to do without seeming to mind what the public thinks of them; the lack of this characteristic is a most ordinary and insufferable defect in statues and in actors. Many French and Belgian artists possess it to an undesirable degree. Truly, Carpo can make the stone laugh, and the marble cry, as none of these Italians can, but there is a Carpo as there was a Coustou, a Jean Gougeon, who, without peers, leave imitators, but no disciples. (Carpo, just dead between writing and correcting this page, was the marvellous representative of imperial immorality; as great historian on marble as Balzac and Dickens.)

Among the objects of scholastic interest there came from Munster the sculptures and animals carved by H. Landois; the anatomical pieces of J. Plaschke, executed in half-relief in a manner which recalls, but does not equal, the clastics; models of animal and vegetable anatomy of Doctors Auzou and Lemercier, so frequently met in American schools. The collection of crystallography executed in glass for schools by Frederick Thomas was a great success. There were also immense maps, one of the world, in relief, 18 × 16 feet, by Adler of Hamburg. Their polytechnic schools may be equaled by that of Paris, and their technological institutions may be rivaled in this country. The models from the chemical laboratory of Rudolph Arendt, of Leipzig, are like so many schools of manufacture of chemicals and medicines for which Prussia is already noted. Thus her multiple ambition seems to embrace everything; at least it lays in her schools the foundation of a future prosperity more enduring than that due to predatory victories.

To attain this new aim she has armies of children painting, drawing, chiseling, calculating; other armies of adolescents producing, at the lowest rate, objects of taste, mode, fancy, fashion, and trying to be artistic. Will this last word provoke a protest from those who, in 1870, have seen New York girls cry because war forced them to receive the fashions of Berlin instead of those of besieged Paris? But French arts and fashions were no better received in Europe, even at Gaillon in the tim of the Primatice and of Francis the First. Yet not long after, the Italian artisans, being oppressed and killed by the nobility, were welcomed by Henry the Fourth, and soon French ruled in the arts.

53. The Portuguese schools have comprehensive historic tableaux, somewhat in the manner of the synchronic tableaux from Michelet of France. Spain sent little of interest besides her living specimen illustrative of the education of the deaf-mute and the blind—Martin y Ruiz—and elegant writings from the school for the blind. Let us, however, note the school-models of anatomy of Fernando Velasco, particularly a vertical section of head in stearine.

54. Austria has, besides the best kindergärten, excellent schools, at the head of which is that of the Leopoldstad. In the higher and professional grades, technologic institutes, and academies of fine arts, that of Prague sent unsurpassed cartons of flowers in water-color, and Hungary contributed large collections of photographs of vegetables precious for teaching natural history. Bavaria, with less abundant materials, shows the same direction of education of youth. Württemberg which its excellence in the popular art of carving, of which the school is traditionally in the Hartz Mountains, and of which the products, pleasing by their very awkwardness, *naiveté*, find buyers all over the world. The nearer we come to the Rhine the more *Frenchy* the forms of education, and its products. Our limited space forbids extending these remarks, which will be concluded in the next paragraph.

55. We will call the next group German, vague expression of the

unsettled limits of the empire. It contains, if not the largest collection of objects of education, what is better for our purpose and the more characteristic. The Prussian school is more educational and military, being organized to breed scholars and fighting men. But it is easy to discern—above the present status of these places of *breeding*—in the French of Montaigne, *nurture*—a new aspiration toward supremacy in industry, taste, and art in various forms. To attain this supremacy, the schools are constantly enlarging their curriculum, under the leadership of philosophical and far-seeing teachers, who, after all, are the true leaders in Germany. At Lyons, at the Gobelins, at Sèvres, St. Gobens, &c., France once became the center of artistic industry and the arbiter of taste. But now the artisans—whose type is the Lyonnais, over. worked and deformed by the hardship of industry to the proportions of *canuts*—now that the French bourgeois declare that they have not killed enough of them, ("*Nous n'en avons pas assez tue*," said in 1873 a well-known man to the writer of this paper), the artisans, distrustful and disheartened, do not learn drawing nor practice their trade with zeal, and they have already lost some of their skill with the departure of the feeling of security, and they emigrate when they can, to escape the plots in which their oppressors try to involve them. Such are the signs of the passage of the crown of art from one country to another. Forty years ago Victor Cousin, in a report on public instruction, made the same prophecy. He declared to the King and to the Nation that Prussia was already ahead of France in matters of education, and if France did not make a supreme effort to raise the standard of general education, her decline was at hand, and Prussia would soon be the rude leader of Europe. Those who laughed at this prediction in 1840 tore their hair in despair in 1870. The warning of Victor Cousin was given to listless France; but it must be heeded by any nation which, as a nation, has one pennyworth of common sense.

56. Though laboring under the disadvantage of being possessed and ruled by mitred Roman proconsuls, Belgium owes to the proximity of Holland excellent municipal schools. These schools sent to Vienna geometrical figures made of wire, which render exclusively the outlines, and others of wood or zinc, of corresponding forms, by which comparison the sphinx-like explanations in $A \times B - C = D$ are replaced by a single glance. Another improvement of much importance is the mode of giving pupils a knowledge of the meter in the school of Professor Galet of Brussels. The meter is the *étalon*, or base of French mensuration; we will presently have occasion to discuss the modes of instruction relating to it.

57. The French schools exhibited at Vienna quite extensively, but not equally. The first object attracting attention was the vast model of the manufactory of school-apparatus for Paris. It turns out everything which could be made of wood, iron, or plaster for schools. It is useless to enumerate them; and, besides, all was not shown in Vienna; there

were missing things which could be seen only at the establishment in the *Île Louvier;* there were piles of Christs, angels, virgins, cherubs with swords, flambeaux, &c. One must see these casts, ignominiously piled in the expectation of becoming sacred and of being worshiped and implored in their turn, in order to comprehend the depth and distance at which the children of France are kept from the true God; and, conversely, the denial of God by the atheist sooner than to acknowledge such deities. From the manufacture of this Olympus, whose gods recall the expression of the ferocious art of Zurbaran without his genius, let us come down to that of the desks and benches. They are made of the very best material, oak, and of forms fitting only, because filling the class-room; straight, long benches without back-supports; continuous desks without limited seats. Yet these popular arrangements are generally superior to those of some first-class colleges, where the seats are so aged or wormy, the rooms so ill-ventilated, that, when the door has been shut half an hour, the closeness of the smell repels the visitor, at least till fresh air has been allowed for some time to precede him. No place for standing or for movement. In this closely-packed room and confined atmosphere no wonder that the children become restless; and when the signal of recess is given they leave with a rush which has more the character of dear necessity than of the impetuosity of youth. They do not scatter; they run away.

58. Exhibitions give an idea far different from the reality on another subject, the location and character of the buildings. Those we saw at the *Welt-Ausstellung* might have been either rooms in a large school-house, or isolated school-cottages, surrounded by a crowded neighborhood, or in hay-scented meadows. Besides, their erection may have dated so far back as to preclude the freshness of look which pleases in the model, or the reverse may be true. Lastly, some radical defects may have been obliterated inadvertently, or intentionally erased from the model. So that, to keep within the truth, we must take these models as the representatives of some of the best schools now extant, and also, more at large, as the types toward which will gravitate the ideals of the next school-builders. These remarks apply with greater force to the school-*materiel*, than to the building itself. Viewing the subject in this light, one can easily conceive how important is the part (*rôle*) of the critic in relation to these exhibitions. For, if the exhibited types are not completed or corrected by a severe and just criticism, they will be accepted as ideal for a period during which they will preside to the realization in stone and wood of incalculable mischief, as has been the case, for instance, with the palaces erected for the insane. Whereas, when the new types—as those of the *Welt-Ausstellung*—are presented to the mind with their legitimate corrections, the present realization of the ideal school will gain in thoroughness, and the future types of the next exhibitions will ascend some degrees higher toward perfection. To tel- the truth as we understand it, it is not so much the standard of the last

exhibition which determines the progress of the next, as the thoroughness of the criticism which, digested by the masses, forms the staple of future public opinion.

It is by looking thus alternately backward and forward, after having compared the models of the *Welt-Ausstellung*, the Puebla Street Asylum, the Pape-Carpentier and Lemonnier schools and *Unions scholaires* of Paris, the schools of Havre, Bruges, Brussels, Haarlem, Geneva, Lancaster, (England,) where young operatives come from the neighboring manufactories to learn and rest; the Gheels' school raised under the patronage of Ste. Dympna, the Lyons Unions, suppressed by order of Notre Dame de Fourvière, the New York primary and grammar schools, and the cross-road log-houses, from which quietly issue at recess the well-tempered—because not repressed—young farmers, who perch on the next fence like birds, talk of far-away lands and waters like poets, and of the future like men; it is after seeing these, and many of the intermediate or out-of-the-way delineations of what pass muster for *schools*, that we hazard a few suggestions in regard to what we consider their next desirable improvements.

59. The school must be on the highest ground of the district, separated on all sides from other buildings, completely isolated from water-closets, and yet they should have pure water in each room. The building is small or large according to the population; in the largest each class is to be separated, with distinct times of entrance and exit for each class and for each sex.

The surrounding grounds should be well drained and sunned, purified by some vegetation appropriate to the locality, the rest graded and graveled for exercises and sports, and also for the prosecution of a part of the training in the open air or under movable canvas when the weather permits. In the school proper, the large openings must be directed mainly toward the sun, and the air should be as steadily renewed as the water in a stream.

Excellent seats, exactly fitting the size and shape of children, (the old word *form* would better express our idea,) are necessary to intellectual attention. The desks, too, must be selected or expressly made for each pupil, according to the directions given by R. Liebreigh in his work on school-material, and the models this talented professor caused to be made by order of the lord mayor of London.

60. Two other questions arise from the same subject: Must the seats and desks be continuous, or connected by fours, threes, or twos, or single? We have seen that continuity agrees with the natural demand of infants for support in the *salle d'asyle;* later, it gives occasion—as shown in many primary class-rooms—for encroachments of one pupil on another, petty Napoleonisms and their sequels. Isolated seats are preferable for the troublesome, and in the drawing and mathematical rooms; triple seats may be good to keep a good but restless child bound by the example and position of two studious ones. The twin desks may serve the

purpose of rewarding pupils by pairing them or to put a child who needs help in his studies under the wing of a helper.

The habit of filling up the class-room with furniture and piling the scholars on top has been modified in the *salle d'asyle*, as we have seen, and must disappear from schools and colleges. Except in a formal auditorium, where students, assembled for a short time passively listening, are compacted into a massive central block; the school-room must afford space in which the living may move. Let the seats and desks recede toward (not against) the walls, and leave the center free, as an invitation to the children to come out and exercise their competitive and spontaneous faculties; be arranged in this somewhat circular order, which is not formal and is most calculated to make the pupil and the teacher face each other, and, particularly, which causes the light to fall at the proper angle on the objects of study, the attention of the pupils is easily fixed, and the control of the teacher over their *physique* is made more complete without effort or distraction from the teaching proper. The Swedish platform seems the best arrangement for the teacher; that of New York is too bulky considering the generally *petite* form of our intelligent lady-teachers, who have to spend more energy than could be imagined to counteract in the mind of the pupils the effect of incongruous proportions. Children perceive them so keenly that this calls for a reform.

61. There must be blackboards, not only behind the teacher, but in every available place at the proper height on the walls; and when you have so many, you have not yet enough. This assertion is drawn from me by the recollection of the school for the deaf-mutes of Aix la Chapelle. There, besides the walls, all the furniture is black and constantly used for blackboards; and why not? Dr. W. Linnartz, who has organized this method of teaching, deserved a higher place than that to which I assigned him in Part II of this report; but who can tell all that he has seen? The wonderful use of every available piece of wood in the school for writing, drawing, calculating, and conveying to or receiving information from his pupils is worth transferring from Dr. Linnartz's to the ordinary schools.

All available places next to and above the formal blackboards are naturally enough filled by charts, illustrations, specimens, and instruments of demonstration, which must vary according to the requirements of the locality and the requirements of the population.

Though the school-room, when so full, may appear in danger of being cumbered—which would be for the children a lesson of disorder—there is really little danger of it, since the center of the room must remain always free, and because the last minutes of each session must be given to the restoration of everything to its hook, drawer, shelf, or closet by children *honored* with this trust, and given it as much as possible in rotation. So much for a lesson of order which leaves its imprints through life.

Otherwise, and in the most general terms, everything about the

children must be simple, concentric, and concordant. All the lines should be converging to unity, representative of their destination; all the colors harmonizing in one tone, as in a Mozart creation, so that the mind becomes concentrated by the centripetal direction of the surroundings, and the senses pleased, without excitement, by the neutral concert of the accessories.

Another means of relieving the school-room from its crowding, and the teacher from overwork, is the formation of garden-schools, where lessons in natural history would be given to children coming in small parties. In the country, nature is at the door, and its processes of vegetation may almost be studied from the window of the school. Not so in the cities, where dry herbariums will never do for *Jardins des Plantes.* It is mortifying that no sooner had New York opened her Central Park than designers began to replace trees and grass by stones and bricks; but none thought to grow along its neat paths, for comparison, beds of American, European, and Asiatic trees, plants, and flowers, *graminaceæ* and *orchidæ;* the esculent opposite the toxic; those nourishing by their roots, (rhizomes,) bulbs, sprouts, leaves, blossoms, pods, fruits, seeds; the medical and the textile, the feeders of the silk-worm and cochineal, and the plant-of-prey which devours insects. This would be a school-room instructive and airy. For this and other transient and special instruction there would be circuit or itinerant teachers.

There was in Lancaster an orderly contrivance with which to fill an hiatus at this place. Over each seat hangs by a pulley a string with a hook on which to hang cape and basket, and to carry them up or down when needed; so that fifteen hundred pupils get their things to lunch or to start away in a second, without possibility of bickering. We approve of this strict order because it is not repressive; other forms are more objectionable than accidental disorder, because they create an irresistible necessity for reaction.

So it is always fair, and often politic, not to represent the rules to children by stringent material barriers, whose very prominence provokes infraction. For if their good sense tells them to obey, the rudeness, and often the multiplicity, of such orders invites them to break through the whole system of restriction. As an example in point, take the spirit of the French *collégiens* at large, and look, for instance, at the dormitories of the old College of Henry IV. If you inquire why the windows are barred more strongly than in an insane asylum, and little less than in a prison, the answer is that the pupils would go through them to do mischief at the certain peril of injury or death. If it seems strange to you that there is only one light for two rooms and more than a hundred beds, and that a single one shining dimly and inaccessible at the top of the door, strongly guarded both ways by iron gratings, they will say that if the pupils could reach that light they would extinguish it, and commence rioting in the dark, and soon the place would be set fire to; and this is the truth. Through the smallest aperture in

the net-work of compression, off rushes, not the child, boy, or lad, but a very monkey itself as created by the impossibility of showing manly qualities. In proof of this assertion, I have seen in vacation-days these same monkeys exhibit toward their mothers, sisters, and their social acquaintances the most urbane qualities of the mind and heart. Nevertheless, outside of the family they will carry into their worldly relations this negative and (to some extent) anti-social spirit of resistance inoculated into them by material as well as by moral compression. This is said as a warning.

62. After referring to the furniture of the school, we would like to review the apparatus directly used in education. But they are so numerous, and we have so little time, that we must limit these remarks to two of them: the measures used to teach dimensions, and the book in its relations to the hygiene of vision, and to the fitness of its contents.

Is it true that ideas develop more readily where they are not born? I have seen in the schools of France—motherland of the metrical system—the *mètre*, its fractions and multiples, folded and shut up in a glass case, except during two or three lessons in each year; and, on the contrary—as I said—in Brussels is that same measure of length standing vertically in black and white on the wall of the class-room, a constant invitation and provocation to the eye of the pupil to perceive and to retain that idea of proportions which can enter the mind only through the eye or touch. This leads to the suggestion that, if the *mètre* was transplanted here, and painted in our school-rooms, we should improve in teaching its system by giving sight-lessons in drawing and cutting papers, sticks, threads, &c., from this standing measure, (*étalon*,) until it would stand as correctly behind the forehead as on the wall.

63. In regard to the book: the teacher knows—or does not know—that the eye has a power of accommodation represented by a center, or *norme*, and by an extension which permits it to see, at almost any distance, objects of almost any size. But he certainly does not know that if the exercise of this faculty is commenced too young, or carried too far away from its *norme*, the center of accommodation is displaced, the sight altered, and other organic defects are produced. But this is not all. As we know, by the natural history of the fishes of the Mammoth Cave of Kentucky, that the eyes would submit to almost any conditions imposed upon them, even to disappearance when they are not called for by the presence of light; as we see our very young children poring over such very badly printed books, and as myopia is so fearfully on the increase that younglings need spectacles nowadays; may we not be destined to contemplate the time when the children of our fashionably myopic population will be compelled, like the Kentucky fishes, to leave their organs of vision in the cave, or to come out with a supplementary one, somewhat in the shape of a binocle, astride the nose? Otherwise the problem can only be solved in the old-fashioned way of making

children read very late, in large, neat print, and very little, from very good books, for the reasons above given, to which may be added the other, expressed in 1754 by John Locke: Children (he says men) "of much reading are greatly learned; but may be little knowing."

This brings forth the question, What are the qualities desirable in school-books? Although in the concrete these qualities depend on the mental conditions of the child, on the grade of the school, and on the point in the curriculum at which he has arrived—a whole world as seen in the *Welt-Ausstellung*, and of which the dimensions forbid description—we can abstractly define a good book for education as one which will interest and instruct, set the mind thinking, and which does not denaturalize the sympathies by a fear of phantasms.

The history of Alexander is recounted to our children as a bloody escapade. Nothing is said of his conquests in natural history or in geography, or of his establishment of new arteries of commerce and civilization; nothing of the scouts sent in every direction to supply Aristotle and his disciples with rare animals, new fruits, and plants. In these expeditions to the Indus and Oxus, branching out to the Indian Ocean, the Red Sea, and around the Cape, his generals became infected with a love of science. Their greater rivalry after his death was not on the battle-field, but in Pergamos and Alexandria, where Seleucus and Ptolemeus emulated each other in the creation of zoological and botanical gardens, libraries, schools, in which they followed the courses of study like the common students, and with them, and prosecuted experiments in materia medica, toxicology, and physiology with the masters, Herophilus, Erasistratus, and others.

The French expedition to Egypt is told in the same vulgar spirit. The *Directoire* had sent—besides an ambitious general—a scientific commission, of which the story of the labors, commenced by the folio reports of Denon and his colleagues, was continued by the opening of the Isthmus of Suez, and will not be closed till the civilizing idea of Alexander shall have embraced three continents. A history written on such a basis would give our children noble stimuli to intellectual ambition.

Hachette of Paris and the firms of Leipzig sent books of which the object was to bring the child to be *vir etiam civis*. Mame, of Tours, and others of Cambray, Laon, Liege, print books made to capsize and overthrow the mind from infancy, and they reprint the stereotyped classics, Bossuet, Fenelon, Buffon, &c., with alterations, suppressions, and interpolations which make them pure forgeries. Mary Muller, of Brussels, is the worst of this class, and reprints the most celebrated books largely demanded in spite of the condemnation of the congregation of the Index; but behind the title-page they fill up the volume with vilifications of the author and parodies of his book. And of the lowest class are those firms of the rues Servandoni and des Sts. Pères of Paris, who, like Brepols of Turnhout, (Belgium,) teach by text and images the *credo quia absurdum*. Is it correct to say that since there are so many bad school-books, with

so few good ones, it would be better to reject them all? No! For verbal teaching can and does go the wrong way a good deal farther than the book, and without control. Therefore let us keep our school-books and steadily improve them, as they form by their bulk of acquired knowledge a barrier against national backsliding beside Sicily, Spain, and South America. We must be vigilant, for when the congregation of the Index shall have a legate or proconsul among us, instead of working stealthily at the destruction of the ideas upon which our liberties are founded, they will work at it as defiantly as they do in Canada.

CHAPTER II.

THE SCHOLAR; HIS HEALTH-BOOK AND HIS TEACHER.

THE PHYSIOLOGICAL PRIMARY SCHOOL—METHODS OF TRAINING.

64. As the child is the outgrowth of the infant, so the physiological primary school must be an extension of the infantile experimental field of life, equally misnamed "school" or "kindergarten," since his school is everywhere he can touch, hear, and see; and what he can seize of the world is his garden.

In the perfect elasticity of his free existence—if he has not been taught what he cannot perceive nor comprehend; if the fair play of his senses and of his movements has been but imperceptibly watched and corrected; if his ear has become sensible to speech through its music, and to music through the sincerity of its tunes; if his hand and foot are nimble and sure; if he is familiar with humane sympathies and ignorant of the cowardly feelings caused by compression and superstition—his movements are gracious, his sensations expressed by a pleased countenance, his plays have gradually become laborious, and from the early morning he *works* hard at something, till he falls asleep on the knee of his mother; his voice tells us as much by its intonations as by words; though his vocabulary is not large it is select, and is often enriched by nugget-like expressions; his feelings toward his kin are intense, he having learned early to cry or to laugh when the bosom of his mother was agitated by sorrow or joy; and he is correct on the main points of right and wrong; only for fear of doing wrong he will sometimes do right to excess, as he loves. Then he is prepared for his primary training and knocks at the school-room door. Let him enter, and receive him cheerfully, but not before you have taken the *bilan* of his forces, in order to exactly know what he can spend, and what you must spare of his vitality and of his caloric during the combustion-process of educational labors.

65. After filling up the ordinary questions which occupy the first lines or pages of an ordinary health-book, you note the defects of the hand, of the speech, of the special senses, and particularly of the eye and ear, the relative proportions of size, weight, and age, and those of the parts of the body among themselves; then the possible differences between the two sides are tested as previously treated of theoretically in Part I. If one side, generally the right, is most developed or even distorted at the expense of the other, a thread hanging from the nape of the neck will show the extent of the deviation, and other simple means of mensuration will show differences in the nutrition of the limbs on both sides.

Measure contractility also with the dynamometer, the sensibility with the esthæsiometer, and the relations of central to peripheric temperatures with thermometers, thermoscopes, &c. When you have found these differences, or no difference, you record the results in figures, which remain like *étalons* or standard measures with which can be compared all subsequent deviations and returns to the *norme* or state of health Previously to the popularization of these means of knowledge, teachers labored under two difficulties: one, the ignorance of the true condition as to health of their pupils, and the o her their ignorance of the means of ascertaining it. But now the invention of the method of positive diagnosis has rendered possible the establishment of health-records in schools, and the simplicity of their operation has rendered their use easy by all teachers. Therefore the time cannot be distant when the indifference of teachers, or their neglect of the employment of these positive tests, which are already familiar to mothers and nurses, will be considered as a proof of incapacity, and make them amenable to grave responsibilities. For children can make believe that they are sick when they are not, thus beginning in sport a career of deceit; or, unconscious of being sick, they cannot work as well as usual, and get punished, discouraged, exhausted; or the teacher, ignorant of the fluctuations of health, of the warning given by certain changes of rate of temperature, breathing, or pulse-beat, of the action of external temperatures on the body and mind, continues to distribute work in the most exacting—as he believes just—proportions, not only on every war m or cold day, but to every child sick, sickly, well, or exuberant, at the risk of imita ing the classical murders quoted in "Lessons from Orleans," from "Clinical Thermometry and Human Temperature," second edition, Wood & Co., 1875, New York.

As this question is one of vital importance—I say *vital* not figuratively, but in earnest—teachers cannot study it too soon, and superintendents of schools, presiden s of academies, and other officials cannot organize these record-books of the vitality or devitalization of their charges under training too mathematically These figures must be not only established at the entrance, but continued, as on a book-account of profit and losses, before and after the several parts of instruction, to show which of them alters most the normal conditions of vitality, and which least upon the movement of these undulations. The actual teaching and exercising may be apportioned on the secure basis of physiology; and from the records of a period of several years, embracing the growth and the education period, can be judged with mathematical certainty the kind of labor, studies, and habits which will insure to the subject of such a monograph the longest, healthiest, and—as far as it depends upon himself—the happiest life. Here the philosophy of education is expounded by its physiological results. But as only the mother—not a distant physician—can keep this book-account for the infant, so the teacher alone can keep it for the youth committed to his care. To teach is not only to spen , but to husband, the vital resources of the next generation.

CHAPTER III.

SCHOOLING; ITS OBJECT, MEANS, AND TENDENCIES.

OBJECT OF EDUCATION; EDUCATION OF THE HAND, THE SENSES, THE MEDICAL SENSES THE INDUSTRIAL SENSES, AND THE LANGUAGE; SPECIAL TEACHING; GEOGRAPHY.

66. When, seeing in the *Welt-Ausstellung* the immense efforts made, and the treasures spent by nations, partisans, and sects, to take possession of the child, even by influencing the impressions of the mother before he is born, one cannot fail to reflect upon the nature and aims of education.

Education is the right of every child, the duty of every parent, the bond of every community. The feeling which binds those educated together—more subtile than electricity—is nationality. If the family and society do not educate, the foreigner (by his feelings at least) will, and he will make strangers of our offsprings. Any one so estranged who dare act the citizen, is worse than Benedict Arnold, born an English subject, and traitor only to a nationality not yet acknowledged as a nation. But now this Republic is not only a nation, it is a parent who spends to educate its children more than any other five nations put together. Whence the touching confidence of the western boy singing, "Uncle Sam is rich enough to give us all a farm." Education is that fruitful farm, and Uncle Sam, giving it, asks no other questions than to himself: "How can I give the best?" Prompted by this feeling, the Government has sent commissioners to Vienna in order to learn the best method of education.

There were many things worth noting, some to be accepted, more to be dreaded; and though none were found applicable to this country, the experience acquired permits us to give an answer to the question of the Executive.

The object of education is to prepare children for the work to be accomplished to-morrow.

The work of a nation is so complex that this preparation cannot be objective, and must be subjective.

The school must be organized, not to teach *this* or *that*, but to train the organs by the exercise of the functions; to develop the functions by the exercise of the organs; to elevate the functions to the rank of capacities by their physiological training; and, above all, to keep all the while the balance between the forces acquired by good air, light, exercise, rest, &c., and the forces spent in centrifugal activity and in

the centripetal operations of the senses and of the mind. This tendency of the physiological school was foreshadowed in the preceding chapter when tracing the outlines of the children's text-book. In the impossibility of developing the plan of this training even in brief, we will represent it by a few well-studied parts; the rest can be conceived by simple adaptation or analogy.

Gymnastics and sports are instituted to develop the muscles; many schools have them; all should have a gymnasium, the best being the simplest, in the open air. But, strange enough, the hand—of which so much is expected as the executive officer of the will and of the mind, by force or delicacy—receives only the chance training of automatism expressed—I do not know how in English, but in French—by the vulgar proverb, "*C'est en forgeant qu'on devient forgeron.*"

67. A.—*Education of the hand.*—It is unfortunately the fact that the hand has for years and ages struggled against matter to make it express or accomplish ideas, receiving all the while the least possible help from the mind. But the great progress of hand-work at the *Welt-Ausstellung* over the corresponding exhibits at Paris and London, and the drawing of the French, German, Italian, and Swiss schools, show that the hand is more and more educated intellectually, if not yet physiologically. The object-lessons have largely influenced the advent of realistic taste now prevalent in art and industry; but when the physiological education—of which these lessons are only an inverted and partial application—prevails in the schools, then the hand will rule, and the question will arise, The hand of which nation will be queen? Why should it not be that of America?

There is something in chiromancy. As the aspect of the head bespeaks mental power, so the hand indicates its creative capacity. Like the head, the hand is amenable to greater perfection of shape; hence to untold dexterities. If we judge of the *American hand* by the promise of its forms—long without puny tapering, its palm large enough for a strong clasp, its phalanges well defined, without articular nodosities, the nails well made, supporting a pulp equally sensitive, firm, and elastic—such a hand well trained must become a match for the most skillful. Here, coarse hands are of foreign origin, made clumsy by hereditary overwork, and can, by culture, be brought to an average of dignity and usefulness, at the latest in the second generation. But the correction by education of the anomalies of form, of contractility and of tactility of the hand, forms a special department of education.

In its general application the education of the hand aims at exercising the muscular and nervous apparatus separately and conjointly; making the hand obey an outside will or example, or the internal will or thought; executing either of these dictates in the shortest time, in rational order, with the greatest correctness, force, delicacy, and finally art; habituating the hand to convert all labors of repetition from intellectual to automatic without losing the appearance of the former; work-

ing alternately under the dictates of the will and under the impulses of automatism, without ever mixing the former, in which the hand is obedient to the brain, with the latter, whose repetitive impulse is from a near ganglion when the mind takes rest. These exercises must be made singly, in small groups, by large assemblages, on command, on imitation of a person or of objects. Education trains the sight as well as the hand to wonderful quickness and precision, and prepares these organs for higher labors.

Both hands must be equally trained, the right and the left separately, alternately, and together, and must be made to execute movements of totality, or of their small phalanges singly or together, by the most rapid and correct simultaneity of the will, the eye, and the hand.

Moreover, when some inequality is discovered, not only in the ability of the two hands, but in the growth and action of both sides at large, two orders of correctives must be ready in the school for application, one to the child directly and personally, the other resulting from some pre-arrangements in the school. By the first, as soon as a difference of size or symmetry is manifested, the *dexter* habits of the pupil must be altered into *sinister*. Eating, cutting, brushing, and the menial services which the hand performs as a domestic of the body, must be intrusted to the left; even drawing, writing, and a few automatic games and exercises, like spading, sawing; at the same time that the lacing, buckling, buttoning of the garments must be altered to be worked by that hand. By the second and more general device it would be well to have the school-arrangements, as the doors and windows, altered and disposed to be moved by left-handling, so that not only the children deformed by prior right-handling would improve, but so that new cases of this deformity would become as rare as they now are frequent. So this physiological training of the hand and of the left side is urged on the ground of necessity in favor not of a few children, but of all, on the plea of the dualistic structure of the human body, as developed in Part I.

68. B.—*Education of the senses.*—In educating the hand as the executive officer of the will, one soon finds that it is also the surest carrier of the impressions produced by contact; that is, of the general sense of touch, and of the special sense of tact. These, like the other senses, are susceptible of education, and they were educated by the ancients, as it appears from the expressions, "*tactus eruditus*," "*eruditus oculus*," "*eruditum palatum*," which imply education.

The education of the senses is as useful as that of the mind; for what an educated mind can do without the help of educated senses is seen uselessly shelved in our libraries; what the senses and the hand unaided by the cultivated mind are doing fills up our stores and is eagerly sought after; and what both equally educated can accomplish in concert is fully exposed to view where the products of the combined efforts of man are proudly facing each other; therefore, let us exhibit

the necessity of founding intellectual upon sensory education by two examples: one of the impossibility of using intellectual resources when they are not supported by accurate perceptions, the other of the rapid degradation of the creations of taste when they are reproduced by unskilled hands and senses.

69. C.—*Education of the medical senses.*—The profession of the writer may serve, as well as any other, to show how the effectiveness of an intellectual education depends upon an equally thorough sensorial training. The capacity most needed in a physician does not come to him so much from the accumulation of knowledge and traditions; as from the operation of his systematically trained organs of perception (the senses) and of execution, (the hand.)

a. The first sense called into requisition in medical practice is the smell. It must be educated, by a proper curriculum, not only to the point of diagnosing by its specific odor almost every disease, but to that of reconnoitering when patients and others are in dangerous *milieux*, with the scent of a dog, if not with the eye of a tercel.

b. The sense of taste or gustation ought to be called in requisition at the bedside oftener than it now is. Once, much of the *materia morbi* was tested by it, and though chemistry has superseded it in many places we must not forget that it has discovered several diseases, (diabetes, for instance.) It is still daily called to control the quality of food or drink; thus it is capable of preventing unpleasant or fatal mistakes; but to train that sense demands a patient training with hundreds of substances.

c. The eye of a physician must read countenances more easily than books; but this reading has its alphabet which he must master before pretending to understand human expressions in health, sickness, or peril. The infinite modalities of life are expressed by lines, contours, colors, and shades; to catch these modalities and to seize their relation or their antithesis, is the spelling of the young physician, preparatory to deciphering and naming diseases at the clinic. But the medical student who has not received the primary education of the senses is too often incapable of reading what Hippocrates calls the *signs*; he can study, but cannot observe; he knows so much, and can do so little.

d. The hearing and the touch have culminated in the arts of auscultation and percussion, which are now taught in hospitals, but for which there is no preparation in the primary and grammar schools; so that medical students often know too late that they do not possess even the ordinary sense of hearing, and that they are far from being able ever to use it as a clinical instrument.

e. The hand of the physician is not limited to the touch, nor the touch to the art of percussion and of pulse-feeling. As the general agent of fact and execution in the practice of physic, it plays a part more important than that of the other senses all together. Indeed, Galen, himself endowed with Hippocratic sight and foresight, and with

Apollonian delicacy of feeling—made such loving study of the hand that its description reads like a poem; it is almost an apotheosis. In this mighty effort he does not hesitate to give to the *tactus eruditus* the precedence, if not the preseance, over the *mens eruditus*. After this illustrious example, we do not hesitate to ask the precedence of the training of the hand over the study of our art; and more, we say, from first to last let us educate the hand: and once educated, let us keep it up to the highest point of sensitive and executive capacity.

We could have taken our example from any other art, science, or technological profession, but should have been at trouble to search for unfamiliar illustrations, and would have encountered the same necessity of founding the capacity of the youth more, and by priority, on the training of the function to obtain capacity, than on study to obtain learning.

70. D.—*Education of the industrial senses.*—Almost all the handicrafts furnish examples of the deterioration of types by the lack of training of the senses and hands. The name *hands*, given to the masses set to work with native automatism only, and without a preparatory education of their executive senses, is perfectly characteristic of the severance of their hands from the higher faculties—a mutilation from which they abundantly revenge themselves by the infliction of moral and financial evils. Let us illustrate these evils by the most apparent of their consequences, the rapid alteration of types by the masses who are engaged in their reproduction without having received a preliminary training of their organs of execution.

New types, called fashions, are constantly created in architecture, painting, *nielling*, furniture-making, &c. Let us refer to that which employs the greatest number of hands, and mostly women. The fashion in all the articles of dress changes so often that it is demoralizing for many, and ruinous for more. Women have been reproached for that, as we think, with great injustice; at least it cannot be denied that, in the time when fashions were executed by true artists, they were transmitted almost without alteration from mother to daughter at least, and that the true Parisian of taste and education changes her style of dress less and more rarely than any other woman, because those who reproduce fashions there remain truer to the type. The cause of the revolutions which we see in dress resides in this: When a new type comes out, with forms and colors, combinations of both, and a fitness to the human form truly lovely, everybody wants it. When it has been executed—let us say, for the correctness of the idea, translated—a few hundred times, it has lost what the French call "*ce je ne sais quoi*," which causes one to dream of it. The third month everybody has it; the fourth, everybody wants to get rid of it, and to have the new one, not yet well started; and why? Because the translation from copy to copy by automatic and non-educated hands has become too unpleasing to contemplate. So the work of millions of people, and the fruitless expendi-

ture of millions of money—without reckoning the greater cost of an almost incurable demoralization—result from a schooling which leaves out of the mental curriculum the senses, feeders of the mind, and the hand, the realizator of its flitting shadows.

By these examples, taken from common human affairs, we see that the hand alone can give precision and durability to the simplest ideas. The same truth becomes more evident in the higher ways of intellect. Who made the great discoveries of our age? Fulton, Faraday, Daguerre, Morse, Wells—men whose hands had from infancy executed the ideas of the mind. When the mind is active and the hand inapt, ideas run to waste, by a mental process we may call ideorrhea—not a rare disease.

This want of primary education of the senses and of the hand, which can never be supplemented by the masses, which is overcome only by a few gifted children, and which is aggravated by the faithlessness of the masters who use their apprentices as servants, has been made the occasion of the interference of religious organizations who, midway between the family, the school, the shop, and the commonwealth, opened, about 1840, places called in France *écoles d'apprentis*, (schools of apprenticeship,) and *ouvroirs*, (working-rooms,) which essentially correspond to an actual necessity of the situation, to "*un besoin réel et incontestable*,' said M. le Comte de Salvandi in his report to the King on the state of primary instruction in 1843. However, the immoral tendency and the danger of these would-be religious traps for children did not escape the foresight of the conservative minister of the most conservative of kings, who directly said, in his parliamentary but significant language, "*Mais il ne faudrait pas que ces établissements tinssent jamais lieu d'école, là où une véritable école est possible. Ils doivent donc être soutenus et encouragés avec discernement, tantôt comme une ressource auxiliare, tantôt comme un acheminement vers l'organisation plus compléte de l'enseignement.*" Since these warnings, this report—which shows, by the by, that it is not original with us to consider this question as endosmic to that of education, unavoidable because it has made itself inevitable—these communistic institutions have been *encouraged*, not with the *discernement* recommended by the minister of public instruction of 1844, nor as he formally said, "as a transitory measure till public instruction should be fully organized," but till they have become, not only in France and Belgium, but in this Republic, in New York and other cities, the educational and social evil foreseen by M. de Salvandi.

In large cities they have shops and classes for show, like those in Paris rue de Vaugirard, containing fourteen hundred boys. In the country, girls are gathered rather compulsorily to sew without compensation, and are given hardly any other education or recreation than hymn-singing. We heard them at Clamecy (Nièvre) express their gratitude by this aphorism: "*Les bonnes sœurs sont si méchantes*," (the good sisters are so harsh to us.) Against this rather severe judgment we would

suggest that the sisters, being oppressed from above, may oppress a little below. An institution of this kind, in New York, managed too by sisters, employs above four hundred girls, treats them kindly, but as inferiors, gives them a low grade of instruction, and needle and sewing-machine work, for which they receive no compensation. Their products, as seen at the Vienna Exhibition, or at home, are inferior to those of the lay-schools of the corresponding class; for instance, to those of Dresden, St. Quentin, Bordeaux, Paris, (Madam Lemonnier's school,) in which girls are taught to engrave on wood, to paint on china, enamel, &c., in a superior manner, and are paid for the work they accomplish in the establishment. But teaching is evidently the accessory business of these would-be religious schools. They make the children work mainly in order to appropriate to themselves their work; they sell at low prices the work of their pupils to put down the money-value of the work of their families, to keep both parents and child in subjection by poverty and superstition, habituating them from infancy to the conventual forms of communism—a communism, the only one to be dreaded, because, incessantly acquiring, never parting with a mite, it husbands its untold treasures to feed or to starve the masses, in order to be able to throw them one way or another in the scale of events: just the dread of Salvandi and the menace of Manning.

So we have plodded even at the antipodes of our subject to make sure that, even there, there was no sincere, nor intelligent desire, nor means to call the physiological training of the senses to the support of intellectual and practical education; and, reverting to the generalities of this subject, we conclude this part, and introduce the next, by the proposition that if the senses have been educated to perceive aright, the language will be all right.

71. *E.—Education of the language.*—When looking at the child in his cradle (Part I) we might have said that the best teacher is the mother and nurse, the best dictionary a mellow voice ringing, in alternation, double and contrasting sounds; particularly when nature or the city begins to rest, the child is better prepared to listen, and falls asleep with the roll in the ear of these new syllables which, after lurking in his dream, come first out of his throat in the morning. But now, what a change! He is at school. The voice of command is rarely softened by affectionate vibrations. He is seated behind big books, in variable but always distorted attitudes, reading, writing, mumbling lessons and reciting them. And what lessons? On what he has seen, can love, searches, desires, is curious about? No! The subjects on which the teacher tries his best to bring forth the faculties of language of his pupils are generally very imperfectly comprehended, and cause in the class but a common feeling, that of indifference. *Vide* the books; full of matter good to *learn*, but not of matter which could provoke children to *talk*, to develop and use their inward dictionary; and the latter is what we are looking for.

Objects and images, though introduced in the school to increase *knowledge*, have been also employed to provoke *language* to come out. But what can teach language better than speech itself? Yes, the great teacher of language is not the master, the book, the image; it is the physiological method of inciting in a child, of propagating in children, the *besoin de parler*, which, from being contagious, becomes unanimous. This method employs two processes, one didactic the other spontaneous. By the first, the children serve as a dictionary to each other in this wise: Supposing the girls and boys on different aisles of the school, or suppose any other division of the pupils; a noun is given to the children of one division, who must find all its analogues and the opposite division all its contraries; or the verbs are given for one division to find, and the adjectives to the other. The child who has found an answer raises a finger; the teacher points with his to the one allowed to speak; every word flows as from a source; hardly any definitions are called for to redress mistakes or to give more relief to an idea. By the second exercise the children serve as models and critics to each other, and being all liable to be called to speak they must, every one of them, have every day something to say. This something must be culled from their self-experience, sensation, or feeling; an incident which has just happened, for the sake of freshness of detail or color; a scene in the street, a fallen leaf, a new pattern, a party, something grotesque, a tableau, or a single witty word feelingly reported. By all means, not only let, but make them speak out their feelings, ideas, dreams even, which light up the transparency of the soul. What can a child be but a hypocrite who reads and writes all the while and hears only two commands, "Be still!" "Silence!" and who will receive his honors only when he can no more spontaneously speak, nor move with ease and grace—a result which is unavoidable in most of the schools for two reasons:

The habit of writing instead of speaking, and of writing from books instead of from personal sensations and self-thinking and feeling, is one of the principal causes of the rarity of original, genuine men; all have copied from the same book, and afterward from each other, till, coming in contact with one and any of them, we cannot detect a difference; all minds alike, like the marbles children play with and leave in the mud, to the great relief of their pockets. A lesser yet grave inconvenience due to writing from books is that all scholars have two styles—one in writing and the other when speaking; one bombast, the other incorrect—instead of a single natural one. Not meaning to strike by this criticism "the man of the moon," we, ourselves, would like to exchange our two styles (of writing and of speaking) for the single one resulting from our own temperament; and for this country, we wish that a physiological education of the masses could perpetuate the double fine-art of standing nobly and of speaking in the manly way which was American before the introduction to books and benches.

Several perils accrue, too, from our inordinate use of writing and

ciphering at school. After years of such work, the young people rise from the bench, and, on the strength of their knowledge of the twenty-six letters of the alphabet, and of the ten figures of arithmetic, fortified by their ignorance of, and their incapacity for, anything else, they demand to be fed as clerks. A pretended education has crippled them. Less modest, many *scholars* from the same bench attempt to write, from the unconsciousness of their reminiscences, books which call in vain for an Omar, whose destiny is more ignominious than fire. Another peril and disgrace of our chirography is that the more one writes the worse is his writing; and when he reaches the doctorate, others can rarely read his writing; nor can he himself, even. Evidently, the rapidity of our thoughts and communications can no more be accommodated by our twenty-six letters than could the Greek mental activity by the Egyptian hieroglyphics or the Phœnician alphabet. The present mode of writing cannot follow the rapidity of the thoughts, even when in the attempt it loses its legibility; it is adapted only to the slowest commercial transactions, and is often found insufficient or inconvenient even in private correspondence. Evidently the time has arrived when a division of labor in the transmission of thoughts is demanded, and the school must be prepared to supply this new demand: first, by the teaching of no writing but the fairest hand, which is possible, if its exercises consist only of two or three lines repeated twice a day like a drawing; second, by the teaching of short-hand writing to all, and its use for taking notes in tuition and reading; third, by the teaching and daily practice of telegraphy in all the inter- and intra-correspondence of the schools, school-boards, &c., each having its telegraphic class, and between the lessons an experienced pupil *at the helm*, with one or more inexperienced ones.

Not to go more into detail, and yet to say a last word in regard to true writing: There are two modes of teaching it, one physiological, which proceeds as the teaching of all other *forms* and *movements*, and the simial, which needs no description, being what everybody likes. In the physiological method the child draws before he writes. In the course of this teaching—from a vertical line to an horizontal, from an oblique to a curve, from the generation of one line from another, from the combination of two or more lines to generate numberless (geometrical) figures, among which are those of letters—as soon as the child from the crowd of figures *recognizes* the letters in books, or, *vice versa*, from the book to his blackboard, they are named to him; he has had the form before the name, instead of the name before the form. This is all-important, for, supposing him to receive altogether and at the same time the double notion of form and name included in *the letter*, the notion of form soon becomes immerged for the eye in the group-notion of *syllable* and with that of *word*, and the hand, in the act of writing, led by the eye, and spurred by the apprehension of the task, attenuates the individuality of each *letter* more and more to reach that of the *word*, and finally it leaves on paper a sort of word-hieroglyph legible only to

those most initiated. Whoever goes to the British Museum, to the National Library of Paris, and to other such places, after having tried his best to decipher affectionate riddles from home, and sees the brick-books of the ancient Asiatics, and the penciled letters and firmans of the modern Orientals, cannot let his beguiled eye fall on his own hand without a feeling of humiliation, and the wish that the next generation, at least, may write a better hand.

72. F.—*Special teaching; Geography.*—We resolved to keep out of view the purely classical matters of the curriculum. However, as a sample of it, and as an example of how different kinds of instruction may be given under the same name, we will consider geography. At the *Welt-Ausstellung* there were large copy-books of geography, and many geographical charts, some almost as fine as good engravings, made, it was said, by the hands of the pupils, (conceded,) without the master's corrections, (conceded, too.) These received honorable mention as perfect in their kind; well deserved. But what will remain of this form of teaching ten, twenty years hence, in the head of the receiver of the diplomas awarded by the commissioners on education? There was also at the *Welt-Ausstellung*, but so lost in papers without name or value that by chance alone I discovered it, a geographical correspondence between the pupils of the primary school of Peronne, in the north of France, and those of the school of Dieu-le-fit, in the south. The young correspondents describe to each other the natural characters, the soil, the products, the manufactures, the usages, festivities, and varieties of their respective towns, townships, and provinces, (*départements.*) These letters, received and answered with manifest pleasure, taught them things impossible to forget. They created among the young writers feelings of interest which promise to ripen into friendship. They made them love the distant places seen in these descriptions as the homes of their friends, and feel that identity of soil and population which is admirably expressed by the word *patria.* This small *envoice* of two provincial schools, full of meaning and promise, escaped the attention of the commission of rewards, which was incessantly called to examine the showy exhibition of the sectarian schools by their active delegates. If noticed at all, the French delegates would have sooner deprecated than recommended it, they being of two classes: the advanced, who stand backward for fear of losing their position, and the retrograde, who want to preserve theirs—variety without difference; both holding any understanding among citizens to be a crime, and would have stamped out this correspondence among children as threatening danger to their government. Actuated by different motives, we present to American teachers this unrewarded mode of making the study of geography lovable or worthy of their imitation. It would correspond to the physiological *besoin* of a large social body to feel all its parts. Besides, teaching more than the book, yet not excluding books, it would have as its effect the commencing in youth of intercourses which would soon bind the new generation in a net-work of good feeling.

CHAPTER IV.

TENDENCIES OF MODERN EDUCATION.

PHYSIOLOGICAL EDUCATION; LAST LOOK AT THE WELT-AUSSTELLUNG; LESSONS FROM THE WELT-AUSSTELLUNG; SEX IN EDUCATION.

73. We said that the object of education is to prepare the children for the work which will be demanded of them to-morrow. We have seen that this work is so varied in its details that they cannot be embraced in a plan of general or national education. But, transferring our observation from the objective to the subjective, we have demonstrated that if the commonwealth cannot pre-educate for all kinds of work, she can train all the organs to accomplish their functions in the most perfectly physiological manner, and elevate all the functions which are under the control of consciousness to the rank of intellectual capacities, and can make them concur in the operations of the mind and of the will. This is what constitutes *physiological education.* We have been at some pains to gather its elements from the *Welt-Ausstellung*, from the special schools for idiots and deaf-mute children, from the sparse traces of it discernible in the schools of Europe and of America; and, after giving a few specimens of it, instead of the full exposition it deserves—but which would be incompatible with the plan and object of this report—we re-enter the *Welt-Ausstellung* to ascertain what is the tendency of human labor for the next score of years. After that, we shall turn a last look upon the school to see what it can do to prepare the children of this Republic, and we would like to say those of dear, hypnotized France for the work which will fall to their generation; and then our own work will be accomplished.

The products exhibited in the *Welt-Ausstellung* show no startling progress.

74. A.—*A last look at the Welt-Ausstellung.*—With a last look at the long galleries, broad pavilions, national alcoves, and cosmopolitan transepts, comes a last thought.

This whole dazzling accumulation of treasures does not reveal any new opening in the human mind. The century, growing old, has lost that enthusiasm which produced Childe Harold, Les Orientales, photography, the steam and electric motors. It wants rest and enjoyment. To that effect it calls on science, art, and industry to bring forth those secondary inventions and appliances dear to the *vieillards.* From this frame of mind, in industry as in everything else, new things are not desired, rather dreaded; any invention (of a new motive power, for

instance) which would disturb the machinery by which the products of labor fall, as it were, naturally, into the lap of capital, would be considered as a curse. Therefore the demand is for those accessory arts which embellish these products and comfort their owners.

Though the exhibition of Vienna showed great advances, it discovered great chasms, too, which education must hasten to fill.

a. In the general drawing of, or on, objects there was little sense of unity of composition, and a great lack of originality, though sometimes with deep meanings.

Let us borrow our illustrations from painting, as not being subordinate to the material, to the substance. If the drawing was often brilliant in the conception and in the pose of simple figures—as, for example, in that of General Prim under fire, by Regnaud—it was feeble in grouping and void of unity in composition—say as empty of a center as the Diogenes of Gerome, even when it was as full of meaning as the Cleopatra of the same artist, which reads like a gossiping chapter of Appian.

b. The ornamentation on silk, glass, wood, leather, offered some patterns justly admired. Most of them, however, were *pasticcios*, indiscriminately good or bad, from good or bad periods—delicious *niels* and garlands from Pompeii, and Bonapartist medallions of women's heads looking like troopers, of men looking like gendarmes.

c. Articles of furniture have not been treated more discriminately. In virtue of the impulse witnessed at Vienna, during the next decade we shall have no choice but between the miniature stool which creaks at a touch, and distorted copies of the chairs of a great inquisitor of the seventeenth century, (*vide* Philippi A. Lamborch, *Historia Inquisitionis*, Amstelsdami, M. D. C. xcii.)

d. On plans, we see the Gothic style adapted to stables, and the ogive of the fourteenth century, crowned by Roman colonettes of the seventh, in churches of the nineteenth century, which rival the opera in upholstery.

e. As an offset, coloring has been heightened one way and softened another, by the acquisition of new shades, or by an assiduous copying of the relics of the eighteenth century. The substitution of chemical colors for the vegetable or for the triturated metallic paints, and particularly the anline compounds, have considerably enriched the pallet and the dyes: chemistry has played the part of painting.

f. A great revival in the plastic arts; in terra-cotta, Delft-ware, and *faïence*, attempts to rival the Bernard de Palissys and majolicas; the re-opening of the glass-works of Venice; the renovated styles of Bohemia and Baccara, (not forgetting the recent efforts of our young Pittsburgh,) are signs of the same order. In all other departments may be signalized somewhat similar defects and similar progress. This is, in our estimation, characteristic of a period fruitful in execution and devoid of inspiration. This movement has a current which, though rendered indistinct during its passage through the conflicting whirlpools of indus-

tries and passions, can, however, be traced, and must indicate the course of the next decade or score of years, and how our children must be prepared by the school to figure at the head of it.

75. B.—*Lessons from the Welt-Ausstellung.*—The meaning of the exhibition in relation to the object of this report is very clear, and its expression may be reduced to a few sentences. The best-educated nations produce the best work. Where the aristocracy alone is educated, there are a few works of magnitude and little of private industry; (Russia, Silesia, Hungary.) Where money does everything, manufactures are abundant and the working classes stand very low in education; (England and in Belgian villages.) More evenness in teaching creates a greater variety of products, better remuneration, and more cheerfulness, which is reflected on the work; (parts of France, Switzerland, the Rhenish provinces.) Even between China and Japan the superiority of manufacture and art is on the side of the latter, which has the better schools. To make the lessons from the *Welt-Ausstellung* clearer yet, we shall view the objects exhibited in two aspects or categories: one embracing in a general survey the works exhibited; the other restricted to the objects pertaining to the school exposed in the pavilions appropriated to educational exhibits.

a. The bulk of the products exhibited shows that we are about midway in a period of execution which will demand more workers, and from them a higher standard of aptitudes of the organs and of ability in the functions; that, at the same time, more production being demanded, in proportion as the power of machines will be substituted for human force—whose lever is in the spinal cord—more artist skill will be demanded from the once ignorant artisan, and will be obtained by special trainings of the hand *creatrix,* whose levers are two. The true creative hand has its levers at the base of the brain in the sensory ganglia; it is educated by the physiological (and rational) conduction of sensations from the periphery to the centers, and of orders from the centers to the periphery. When this education is accomplished, and, in our estimation, not before, may be commenced the education of the automatic hand. This second and secondary form of hand works from the periphery to some near ganglion; it works quicker and more regularly than the former, but has of itself no character except its automatism. If a hand has been long at work from the periphery to the sensory ganglia, it may afterward work from the periphery to an intermediate ganglion, and may continue to produce works which, without being its best, have an individual character, a *manner* which is *his style,* as it is said of all great masters of hand-work. But if the millions who have to earn a living with their own hands come out from school without having received this first and higher training of the working hand, they have to educate it themselves during apprenticeship, either after some type easily caught, producing *pasticcios,* or by the natural pendulum process of automatism for which the hand has never held intercourse with the higher and sensory facul-

ties. Of these three modes of working we have had occasion to note that the second was prevalent at the exhibition; and we have given sufficient proofs that the first must prevail, and will prevail in that nation which will open the school as liberally to the hand as it has to the mind, and thereby conquer the mastery.

b. We found in the *Welt-Ausstellung* many proofs of the real inferiority of the senses to plan and execute the works conceived by the mind. For instance, how the eye betrays the idea in composition. It does not require the eye of a Poussin to discover this defect; and to make it more sensible, though not so forcibly didactic, we will take our examples from the plainest of industries. It was painful to see how the best furniture was rendered offensive or hideous by the disproportion of ornamentation, and truly dangerous by angles where our body expects to find soft places on which to rest; by sharp carved flowers ready to enter the occiput; a volute, to strike the temple of a hasty riser, and other senseless decorations. In tapestry and other stuffs fine color and firm drawing will never palliate the lack of composition; and that defect is strongly marked in all the works which are not copies of the delicious masterworks of the last century, (of Elizabethan style more rarely.) In this respect the school must appeal for a good theory of training to such a man as Liebreigh. All that we can say here is this: The harmony of a composition—whatever it may be, a tableau, a pitcher, a statue, a piece of furniture or of jewelry—consists in it having proportions corresponding to the organism of the eye. As the eye is globular, has a center toward which radiate the objects to form of their *ensemble* a unique impression, which, transmitted to the sensorium, becomes its idea or intellectual image; so every composition which has a *center*, and whose *details* converge toward that *center* to form a *unit*, pleases the mind, because it fits the eye, which is thus enabled to transmit its impression with correctness, at once, without effort. That is one harmony of composition; such a type is demanded not only by the eye, but by the ear, the smell, the taste, and, above all, by the mind; it is a *besoin*, whose absence indicates a low state of culture, and debars one from accomplishing works of any magnitude, and whose loss is one of the precursors of insanity. A nation's taste in composition may not yet be born, but if a nation's work at large gives signs of decadence in the composition of lines and colors, something is the matter with her, (as with the Spaniards.)

These are the physiological forms of training necessary to prepare the organs for work. But, as we have said, the organs must be prepared for the function, and the function must be educated to the rank of capacity. There is only one ignoble kind of work—those who despise working notwithstanding—it is working without an understanding of what we are about. The honesty and policy of giving the children not only the capacity to work, but the philosophy of their labor, will introduce into teaching the higher study of the history and present condition of human labor.

c. There is no better witness of that ignorance of the history of labor to which workingmen are condemned than the universal exhibition of Vienna, unless possibly those of Paris and of London. These vast competitions—not unlike the popular parades of Flanders, mock-fights, processions, solemn entrances of the past ages—seem a masked battle-field, where our cotemporaries compete for the price of modern excellence, with productions masked in gothic, antique, Gallic, Germanic, rustic, rococo, imperial styles, (*et j'en passe.*)

Since all great movements have a motor, what is the motor of this? The desultory mobility of the labor of to-day resembles the chopping waves of the Gulf-stream after a storm—the deep current still runs beneath them. But who can expect children to take an interest in this human stream, unless its course and apparent deviations are made clear? Now they listen with awe, then with enthusiasm. Our schools need a history of the human mind clothed in the armor of the industry of all nations and of the past ages, a microcosm of what is now done and of what was exposed on the Prater. Assisted by such relations, much more interesting than those of Plutarch or of Xenophon, our children, comprehending their position in the wide working world, will choose to be of these rehearsers, to search one of these currents looking for a new discovery, and even to make the smallest invention in the humblest occupation; considering it a reward worth living and working for.

d. But we may be mistaken. That teaching of manly functions to man; of working capacities to a nation of producers; of the solidarity of all of us for, by, and in labor, may be all wrong. There is another plan. Cause the child to learn so much of dead and foreign languages as not to be able to use his own correctly, and give him mathematics enough to apply the rule four and four make three for me and five for him; give him a little polish besides, and when the down appears on his upper lip you send him to—Rome. He gets acquainted with nice fellows who visit Poppœa at the small hours by the small door. When she is tired of him she gives him princely jewels, and a chart—voted by the senators who take their voting-peas from her dressing-box—which exiles him in a district of Judea with the power to levy millions on his countrymen, and the mental obligation to betray them in their last life or death struggle. Such was young Josephus as he describes himself just out of school. Do not forget it—Josephus was educated in the sect of the Pharisees, the Jesuits of their time.

76. C.—*Will it profit our school*—As Paris is *the* place to make us appreciate Croton water, so in traveling we learn to know the good things they have abroad, and to appreciate the excellent ones we have at home. It is not our place to speak of the American high schools, colleges, and universities. The astronomers, engineers, soldiers, seamen, physicians, surgeons, chemists, naturalists, &c., educated at home are highly honored by their European compeers; the lower grades of schools are within our province.

We have seen that our institutions for deaf-mutes and idiots are equal to the best in Europe, and in several points are their superiors. The kindergartens, of more recent importation, promise well. The primary; the grammar schools of this Republic are more numerous than those of any other nation, and reach, in the continental wilderness, parts elsewhere considered inaccessible. They are abundantly supplied, at the expense of the commonwealth, with books and apparatus of instruction; and from the vast structures of the city schools to the log or frame house at the cross-roads, all school-buildings have no other use than that of teaching.

Around the country school there is plenty of air and room for exercise; not so around the city school, which, tall and broad as it is, with its great doors and windows, has yet hardly enough of air and space for its thousands of pupils. It is desirable that grounds be reserved for ventilation and for isolation, as for sport and gymnastics, around these monuments. Their incapacity to accommodate so many pupils is evident, but not insuperable. Without prejudging the question of the advantages of small over large buildings for educational purposes, we may find means of relief of plethora in sending the children in turn to their gymnastics and to the rooms prepared for the special exercises; and in sections to study in the botanical gardens, in museums of natural history, of zoology, and of mineralogy; and, after twelve or fourteen years, we may send them by squads to some manufactory or to the shops of the neighborhood where they may try their hands at something, or at anything rather than nothing. The rich can employ these spare hours in learning some fine art, music, dancing, fencing, foreign languages, at their own expense, within or without the building as may be convenient. The class-rooms thus relieved would be more healthy; they could be all used in the evenings for lessons to adults, and for reading aloud by the children and by their parents under the supervision of a few teachers. These readings would be on subjects like history, which cumber the curriculum without leaving more than a vague impression. The time for real education would thus be augmented and occupied—in addition to the ordinary matters of the curriculum reduced as already described—by the physiological exercises.

Some of these physiological exercises require more room than the class-room can afford, and are too noisy except when taken into special rooms. But others, which are silent exercises of attention, for which the pupil needs only change of position—which is more favorable than otherwise—can be made *in situ*. These exercises embrace all together the training of the motor and sensory nerves, of the senses, and particularly of the hand, *executrix* and sensitive. Special attention must be paid to the speech, much more than to reading and writing. However, the improvement of these two modes of expressing thoughts demands some new developments. Children must be able to read books, the writings of several kinds and ages, and the symbols of stenography and telegraphy. Besides

this, and correlatively, to write an artistic hand, short-hand, and telegrams. The training in the acquisition of a rich vocabulary, in rapid elocution, in receiving impressions and in expressing them with words, as with colors and pencils, as has been previously described.

As soon as the hand and the senses are sufficiently trained, the children, in whom a taste for some kind of work has been cultivated by visits to museums and to botanical and zoological gardens, to scientific and industrial collections, exhibitions, factories, are expected to choose, at least on trial, an apprenticeship. This contingency, in cities where there are twenty thousand or one hundred thousand or more pupils in the district schools alone, must be met with by enlarged means of instruction, particularly in those small arts which insure the independence of the proud, and a small fortune to persistent, thrifty workers, who are principally women.

We have schools of medicine, pharmacy, law, &c. Why few others for professions aspired to by the less ambitious and practiced by the most law-abiding classes? The example of Paris, Berlin, and Dresden cannot be lost to our great cities, which have no better title to greatness than the industrial activity of their millions of people.

77. As to sexes in education, the less we make the children feel their difference, the later it comes into existence. It is one of the merits of the American school to have educated the sexes just as they are made, side by side, and as they are designed to live in sincerity and purity of intercourse. (Natural exceptions would be made more dangerous by the hypocrisy resulting from restraint.) As for the curriculum of the two sexes in the primary and grammar departments, what other difference could be established besides that of comprehension of each pupil? If one sex needs more of this education, it is the woman; because when the man is buying, selling, or manufacturing, she will have to educate her children, after having educated those of others.

This is the second and higher glory of the American school, to have more female teachers than that of any other nation. New York City has above two thousand in the primary and grammar departments alone; there are above one hundred thousand of them in the Republic. Their work is the least remunerative, and the hardest by the expense of vitality it entails, and, worse than that, it has riveted upon them the evil eye of the enemy of free republican schools. So that he who threatens England with civil war, who presses on Belgium as a nightmare, whom divided France hates and obeys, who restores the inquisition and its schools in Spain, and destroys books in Canada, as it did in Alexandria, is the same one who wants to take possession of our school in the name of liberty.

To defend their countries the Austrian, the French, the Prussian, the Russian keeps under arms, in idleness, more than 500,000 young men. To protect ours against ignorance, we must have an army of 500,000 young girls teaching our children, in squads of twenty, and preparing

themselves for the higher duties of motherhood—so much higher than those of paternity: Women—family-educators, barriers against communism.

MM. Guizot, Cousin, Villemain, and afterward Carnot, Duruy, and Jules Simon, tried in vain to protect an admirable body of teachers from the same hatred, and warned France of similar perils impending over her school. Their prudence was set at naught, and we see the first results—only the first. Let us reflect. When crossing the pathless forest of an Indiana bottom, or climbing some declivity in the Adirondacks, I have seen giant trees fall with a deep, sorrowful groan; but it was not from the shock of some noble animal; they were honey-combed by imperceptible things without a name.

INDEX.

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EDUCATION.

J. W. HOYT.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

EDUCATION.

BY

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MEMBER OF THE HONORARY COMMISSION OF THE UNITED STATES.

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EDUCATION.

INTRODUCTION.

1. It is an encouraging sign of the times that educational representations, at first entirely omitted from the schemes of international exhibitions, have at length become one of their most attractive and important features. At the Paris Universal Exposition of 1867, this great interest found recognition; and in classes 89 and 90 of Group X, classes including apparatus and methods used in the instruction of children, libraries and apparatus used in the instruction of adults at home, in the workshop, or in the schools and colleges, the representatives of twenty different countries were awarded prizes on articles exhibited therein.

The nations so recognized at the Paris Exposition, and the total number of prizes awarded to each, were as follows:

	Prizes.
France	278
Netherlands	1
Belgium	10
Prussia and North Germany	24
Hesse-Darmstadt	1
Baden	1
Würtemberg	7
Bavaria	2
Austria	22
Switzerland	3
Spain	19
Denmark	6
Sweden and Norway	3
Russia	1
Italy	29
Pontifical States	1
Hawaii	1
Great Britain	13
Canada	3
United States	3
Whole number	428

This was certainly a worthy beginning of an important effort in the interest of education, and one that reflected honor upon the sovereign

by whose imperial order it was undertaken. But it was reserved for His Majesty the Emperor of Austria and King of Hungary, through his zealous and accomplished minister for education and worship, and through that distinguished friend of education, the Director-General of the Exhibition, to give special prominence to this department by honoring it with the rank of a "group," and by making special effort to insure such a representation in that group at Vienna as would promote the advancement of education throughout the world.

CHAPTER I.

GENERAL CHARACTER OF THE EDUCATIONAL EXHIBIT AT VIENNA.

EXTENT OF THE EXHIBIT IN GROUP XXVI; ARRANGEMENT AND CLASSIFICATION; CHARACTER OF THE COLLECTION.

2. As the result of this enlightened policy of the Austrian government, twenty-four of the nations were represented in Group XXVI of the Vienna Exhibition by a total of nearly four thousand exhibitors; several of them being government ministries, presenting collective exhibitions embracing hundreds of subordinate exhibitions, and a still larger number being provincial and municipal governments, scientific and literary organizations and institutions of learning, each represented in like manner; so that the total number of exhibitors properly enough entitled to a place in the catalogue fell but little if any short of five thousand.

According to the latest issued official catalogue of the Exhibition, now in the possession of the writer,* the number was 3,459, distributed as in the following table, which, for convenience of comparison, also includes the national representations at the Paris Exposition of 1867.

Table showing the number of exhibitors from the countries therein named in classes 89 *and* 90 *of the Paris Exposition of* 1867, *and in Group XXVI of the Vienna Exhibition.*

Country.	Number of exhibitors.	
	Paris.	Vienna.
America (North)	(†)	282
Argentine Republic	1	....
Austria	86	583
Baden	1	....
Bavaria	5	(Germany.)
Belgium	21	70
Brazil	1	1
British Colonies	8	....
British India	....	71
China	....	3
Denmark	14	12
Egypt	2	12
England	35	16
France	602	564

* Several editions were published during the progress of the Exhibition.

† Exhibitions made, but not catalogued; number not officially reported.

Table showing the number of exhibitors from the countries therein named—Continued.

Country.	Number of exhibitors.	
	Paris.	Vienna.
German Empire	....	†226
Greece	5	4
Guatemala	....	1
Hesse-Darmstadt	2	(Germany.)
Hungary	....	316
Italy	69	220
Morocco	1	....
Netherlands	4	11
Norway	(*)	7
Pontifical States	1	(Italy.)
Portugal	(*)	14
Prussia and North Germany	16	(Germany.)
Roumania	....	6
Russia	3	(*)
Sandwich Islands	1	....
Saxony	(*)	(Germany.)
Sweden	14	248
Spain	139	439
Switzerland	10	191
Turkey	1	67
Turkish Provinces	....	95
Würtemberg	53	....
Total	1,095	3,459

* Exhibitions made, but not catalogued; number not officially reported.
† Many of them collective.

3. The arrangement of objects in this, as in other groups of the Vienna Exhibition, was independent of any general regulation, each national commission making such location and arrangement as it saw fit within its own court or portion of the park, which was itself located in accordance with a geographical order, from America eastward to the farthest Orient.

The educational exhibitions, in the aggregate, embraced every conceivable object used in giving instruction in every class of schools, from the Kindergarten to the university, including school-furniture, apparatus, text-books, charts, diagrams, &c., without number; specimens of the work done in every branch of study, including, besides samples of mechanical and artistic work from industrial schools, public and private schools for general instruction, and schools of design, many bound volumes of what are known in this country as "examination-papers," illustrating the proficiency of pupils in the studies of school and college, from the construction of a simple sentence to the solution of the most difficult problems in the physical and mathematical sciences; plans and models of school-buildings of different classes; school-houses of full

size for primary schools; school-reports and reports of the educational departments of state and national governments; published works on education, historical, pedagogical, and philosophic; and, finally, specimens of newspapers and other periodical publications, as illustrating the quality, variety, and quantity of the information supplied to a people through the medium of the periodical press and the publications of learned societies of every class devoted alike to the advancement of knowledge and its diffusion among men.

4. In general terms, the representation was very satisfactory. Nevertheless, there were instances of almost total failure on the part of some of the great nations, and, if Austria be excepted, even the best of the representations were but fragments of what they might have been made with systematic and earnest effort on the part of the several governments.

CHAPTER II.

NATIONAL REPRESENTATION.

EXHIBITS FROM THE UNITED STATES, BELGIUM, INDIA, EGYPT, FRANCE, GERMANY, GREAT BRITAIN, ITALY, THE NETHERLANDS, PORTUGAL, SPAIN, SWEDEN, SWITZERLAND, TURKEY.

5. THE AMERICAN REPRESENTATION.—It was incumbent upon the United States to make a very full and complete showing of their educational condition and progress. For, in the first place, they have succeeded in making a most favorable, and I have no hesitation in saying unduly favorable, impression upon the European mind as to what has really been accomplished, so that great effort was necessary to prevent a too serious disappointment; and, secondly, because, in the planning of the exhibition, America had been assigned the post of honor in education by according to her the presidency of the International Jury for Group XXVI—the first presidency accorded her in the history of such exhibitions.

That the American representation was not larger in this group, and in all respects more worthy of the distinguished attention it received, is lamentable. But the failure to make it all it ought to have been cannot be laid at the door of the National Bureau of Education, under whose supervision the objects exhibited were collected and forwarded to Vienna. General Eaton, the able and indefatigable Commissioner, began his efforts at an early day and devoted his personal attention, and much of the means and forces at his command, to the enterprise; and many of the State and city superintendents of public instruction were also zealous and efficient in their labors from the moment it became apparent that there was indeed to be a national representation from the United States at Vienna.

The immediate cause of our meager representation in this and all other divisions of the American department of the Exhibition is found in the tardiness of Congress in doing what was essential to public confidence. But, after all, our educational representation was by no means a total failure. On the contrary, it was universally conceded that it was one of the very few redeeming features of an exhibition which, as a whole, fell very far short of what was reasonably expected of this great Government and people.

6. As a portion of the educational division of the American department was made the subject of very disparaging comment at the time, it may be proper to give a more detailed account of it than would otherwise be deemed necessary.

The first idea of those who moved prominently in the matter at home was to build, on the exhibition grounds, a model school-house, and to arrange and install therein all classes of educational objects. But to do this required several thousand dollars; whereas it was not then, and did not for a long time afterwards become, certain that the Government would appropriate a dollar for exhibition purposes. And so the plans of the educational committee having the enterprise in charge were at first mainly confined to such efforts throughout the country as promised to result in a fair exhibition of statistics, documents, text-books, furniture, apparatus, and whatever else would help foreign students of American education to gain some idea of the character of our systems and schools. Finally, however, it was determined to undertake the construction of a school-room after the most approved plan that could be devised, and in connection therewith an exhibition-room for the display of duplicate specimens of furniture, apparatus, charts, &c., together with cases of school-books and such articles of use in schools as might be forwarded to Vienna. Upon this decision was based the action which finally resulted in the school-building erected on the exhibition grounds and which was thenceforward to the end the subject of so much criticism and misrepresentation, both as to its cost and its many imperfections. Perhaps it would have been better, in view of the inevitable outlay, and of the fact that it was a compromise of ideas with material necessities, if it had not been built. But the circumstances and results attending the enterprise were such as it was not altogether easy to foresee, and such as they who suffered most from the criticisms of the press and public in America were not largely, if at all, responsible for.

7. As completed, the school-building was a plain but neat rectangular wooden structure, of comely proportions, with a divided hall near the center, one end for the use of boys and the other for the use of girls, the entrance for the one and the other being on opposite sides, and with vestibules at the center of both front and rear. The ridge at the center was surmounted by a neat belfry, and the whole exterior, which was painted gray, presented the appearance of a comfortable and altogether respectable school-house in the rural districts of the United States. The interior was perfectly simple, yet pleasing. The walls, instead of being plastered, were wainscoted to the height of three feet, and for the rest part surface-lined with lumber, canvassed, and neatly papered. The windows, though narrower than is common, afford sufficient light, and the sash, being suspended by cords, were easily moved up and down by a touch of the hand, a novelty in Austria, where windows are almost invariably hung upon hinges. Ventilation was provided for by sets of registers controlled in the usual way, and communicating with proper flues.

8. The school-room proper was architecturally planned for the accommodation of forty-eight pupils, and was handsomely furnished with the requisite number of the National School-Furniture Company's desks,

after the most approved model of that company's desk and folding-seat combined. At the center of the interior side was a teacher's platform, supplied with a handsome desk furnished by the same manufacturers. Globes, black-boards, geographical, natural-history and other charts, including Mason's music-charts, a beautiful melodeon, and finally, a liberal supply of text-books upon the desks, complete the experiment.

Simple and unimposing as it was, this representation of an American country school-room attracted multitudes of interested visitors in the course of the Exhibition, as may be inferred from the fact that, during a single day, as determined by actual count, it was examined by over six thousand persons.

The room on the opposite side of the hall, at first designed to represent a separate recitation-room, and also to serve the purpose of an exhibition-hall for objects not conveniently or properly included in a school-room furnished for daily use, was finished in the same manner as the room just described. But when it became apparent that it would not contain a fourth part of the goods that had been forwarded for Group XXVI, the idea of using it as a bureau for the general commission and a place of rendezvous for all Americans was adopted, and space was assigned to the Educational Group at the extreme northern end of the American transept in the Industrial Palace, where, in the course of time, and after much laborious effort on the part of the commissioners in charge, the great bulk of exhibits were neatly and systematically installed.

9. The space thus occupied—some 40 feet square—was so arranged by the placing of low partitions, book-cases, glass show-cases in uniform style, for the display of drawings, elegantly-bound volumes of examination-papers, &c., and by the arrangement of cloth-covered frames for photographs of school-buildings, statistical charts, and the like, as to constitute four independent courts, or alcoves, of equal dimensions.

10. The northeastern of these courts was wholly occupied by the State of Massachusetts and the city of Boston. In fact, it was called "Boston," for the State's exhibition was confined to one valuable case; and suspended over all, in the most conspicuous place, was displayed a rich and beautiful silk banner, bearing a representation of the city's "coat of arms." Briefly mentioned, the Boston contributions consisted of reports of the board and superintendent of the city schools; complete sets of the text-books used in the primary, grammar, and high schools, 118 volumes in neat walnut-cases; books of reference used in the grammar schools, 103 volumes, including Appleton's New American Cyclopædia; a full set of physical apparatus used in all the schools, 65 pieces; a variety of independent pieces of apparatus; models for drawing; terrestrial and celestial globes; a set of Mason's music-charts; a handsome statistical chart showing the status of all the educational institutions and organizations of the city; a great variety of wall-maps, (including a full set of Guyot's,) tablets, &c.; a dozen pieces of school-furni-

ture; portfolios of photographic views of Boston school-buildings; and a handsome display of class-work of pupils, including many bound volumes and portfolios of drawings, music, and miscellaneous work, and 300 primary slates taken from the schools and faithfully illustrating the proficiency of their pupils. All in all, this exhibition was extremely interesting, unique, and valuable. It was universally regarded by members of the jury, as well as by educational visitors in general, as the most complete and satisfactory representation made in this group by any one city. It certainly reflected much honor upon the efficient superintendent and honorary commissioner, Dr. J. D. Philbrick, who was at once the moving spirit and executing hand in the whole matter, and fairly entitled the city of Boston to the very handsome recognition, in the form of the grand diploma of honor, which it received on the unanimous recommendation of the international jury.

The exhibition made by the State of Massachusetts, as already remarked, was pretty much confined to a case of reports of the State board of education, and a complete set of the reports of all the towns of the State for the preceding year, (1872,) a collection of very great interest and also entirely unique. It was not for this alone that the proposition was made for a grand diploma of honor, however, but for the historic devotion of that advanced commonwealth to the interests of education, and for its commendable enterprise in providing for an able and organized representation at Vienna.

11. The northwestern quarter of the educational court was chiefly occupied by the department of public instruction of the city of New York, whose contributions comprised reports of the board of education, charts showing the plan of organization of the public schools, as well as the educational statistics of the city; a complete set of the text-books used in the public schools of every grade, from the primary school to the free college of the city of New York; several volumes of class-work executed by the pupils, especially in penmanship and drawing; stereoscopic and other views of the interior as well as exterior of schools of each grade, together with a stereoscope of large size, for use in viewing the schools in actual operation; ornamental and mechanical drawings from the Cooper Institute; slates from the New York Silicate Slate Company, and furniture from the National School-Furniture Company. Besides these contributions from New York, there were in this same court other pieces of furniture, from various manufacturers, and on one side a glass case containing neatly-bound volumes of class-work or examination-papers from the public schools of Columbus, Toledo, Fremont, Springfield, and Canton, Ohio.

12. The next court adjoining this one, namely, the southwestern, was occupied by Cincinnati and Chicago, both of which sent numerous elegantly-bound volumes of examination-papers, with statistical charts; also by representations from the public schools of Springfield, Ill., and Dayton, Ohio; from the publishing-houses of Harper Brothers, Ivison,

Blakeman, Taylor & Co., Ernest Steiger, and A. S. Barnes & Co., all of New York; from the house of H. C. Lea, of Philadelphia, and from the Louisville Publishing House for the Blind. It was likewise occupied by school-furniture from various manufacturers; by an extensive case of books, including recent reports of many of the State and city departments of public instruction; reports, catalogues, and other publications of leading institutions of learning; complete sets of all the publications of the Smithsonian Institution, Naval Observatory, Bureau of the Coast Survey, and Post-Office Department, reports of the United States geological survey, with beautiful photographic views of the Rocky Mountain regions recently explored; catalogues of some sixty of the principal libraries of the United States; numerous quarto volumes of the classics, printed with raised letters, from Dr. Howe, of Boston; a pretty full set of the current publications of the leading agricultural, horticultural, and other industrial organizations of the country; and, finally, one hundred and thirty quarto bound volumes from E. Steiger, of New York, containing over seven thousand specimens of American newspapers and other periodical publications issued within the year.

The remaining, or southeastern, court was occupied by the cities of Cleveland, Washington, and Baltimore; by the school-publications of J. B. Lippincott & Co., Brewer & Tileston, Cowperthwait & Co., Collins Brothers, A. W. English & Co., Thompson, Bigelow & Brown, Scribner, Armstrong & Co., A. P. Randolph & Co., John P. Morton & Co., Ginn Brothers, Eldridge & Brother, Robert Carter & Brothers, the Methodist Book Concern, the Boston Congregational Publication Society, E. H. Butler & Co., the American Sunday-School Union, the National Temperance Society, the Presbyterian Board of Publication, and a number of other publishers, represented by a less number of books; and, finally, by a large double case (companion to the one opposite in the southwestern court, and with it constituting a boundary between the educational and geological groups) containing several hundred volumes of geographical, statistical, and other kindred works, together with several immense portfolios of Rocky-Mountain views, &c., all exhibited by the American Geographical Society.

13. The exact center of the entire educational court was occupied by a large, elegantly-finished model of the Franklin school-building at Washington, by far the finest thing of its kind in the whole Exhibition. This model was executed under the supervision of Mr. Cluss, city architect of Washington, by order of the board of education, and at an expense of $1,000. The several stories were easily separable, thus affording an opportunity to examine the interior construction as well as all the details of heating and ventilating apparatus, the seating of pupils, &c.

On either side of this attractive center-piece, and arranged longitudinally with the transept, there were neatly-tapestried frames, 8 feet in height, hung with statistical charts illustrating the educational condition of a dozen or more leading cities, from Worcester, Mass., to Saint Louis;

architectural diagrams of the public-school buildings of Saint Louis, photographic views of the principal school-buildings of Washington and other cities, a set of Prang's and Calkin's natural-history chromos, and photographic views of various public institutions of America, including not a few of our magnificent asylums for the deaf and dumb, the blind, the idiotic, and the insane. Add to this somewhat detailed and yet imperfect description that the high walls on either side and the roof-supporting pillars were covered with numerous maps, charts, and tablets of every sort used in our schools, and the reader will have gained some idea of how American education was represented at Vienna.

14. Quite limited in the space it occupied, and wanting in any organic completeness, because of the hurried manner in which the exhibits were collected, and utterly wanting in that magnificence of installation which marked some other material exhibitions in this group, it was, nevertheless, rather attractive to the eye and extremely so to the mind of the educational inquirer. To the prying student, seeking to acquaint himself with educational ideas, methods, and actual a hievements, it was more than ordinarily satisfactory. Indeed, the remark was not uncommon: "Your American educational department is not so dazzling to the eye as it might be made, but for me it is packed with the most valuable material. It is one of the most useful collections to be found in the whole Exhibition."

15. To the foreign inquirer, the American representation in Group XXVI was especially interesting and satisfactory as illustrating—

(1.) The intelligent zeal of the American people in matters of education, and the readiness with which they voluntarily tax themselves, that the blessings of intellectual culture may be free to all.

(2.) The great liberality of the Government of the United States in freely giving of the public domain for the support of schools for the young, of universities, and of technical schools for instruction and training in the applications of science to the practical arts.

(3.) The unparalleled munificence of private gifts and bequests for the founding of great schools, general, technical, and professional.

(4.) The superiority of our public-school buildings in the cities and villages, and of American school-furniture.

(5.) The great superiority o our text-books, especially those for use in the primary and grammar schools.

(6.) The extraordinary extent to which our newspaper and periodical publications, lecture-courses, and other like instrumentalities supplement the work of the schools by a general diffusion of knowledge among all classes of the American people.

On these points there seemed to be no diversity of opinion. The statistics of education were noted and copied by hundreds of foreign reporters and educators; drawings of American building-plans and school-furniture were made in great number, for use in many lands; and our text-books, outline-maps, music-charts, and other aids to instruction

were studied with the utmost care and apparent satisfaction by numerous school-officers, teachers, and authors from all parts of the world.

16. THE AUSTRIAN REPRESENTATION.—The exhibition made by the Austrian government in the educational group was without parallel, either in systematic arrangement, completeness of details, or in magnificence of display. The collective exhibition presented by his excellency the minister for education and worship was especially admirable. The whole occupied an immense glass-covered court, opening out of the grand nave in the Austrian department of the palace, and was so classified, arranged, and designated by handsome signs suspended from the ceiling, as to present to the eye of the visitor, at the first moment of entering, a perfect general idea of the Austrian system of education. The *kindergarten*, the *volks-und bürgerschulen*, the *gewerbeschulen*, the *hochschulen*, and the *specialschulen*, presented themselves to the eye at a glance; with these systematic and very attractive arrangements of models, tablets, text-books, charts, apparatus, and illustrations of the methods of instruction, with interesting and very complete exhibitions of the work done by pupils in each department of study, and, finally, with systematic and statistical statements of the order and kind of the instruction given in the schools of different grades, as well as of the regulations governing the schools, and the number of teachers and pupils therein.

The collective exhibition formed and presented by the minister, on behalf the government, included 476 distinct representations from an equal number of individual contributors, school-boards, societies, and municipalities.

Besides this remarkable representation of the Austrian government itself, there were two other very extensive collective exhibitions: one by the *Handels-Ministerium*, (ministry of commerce,) which has general control of the industrial and commercial schools of the empire; and another under the general designation of *Frauenarbeiten*, (women's work,) consisting of representations from the schools for girls, existing in numerous cities and villages, and, as a secondary division, of 339 contributions of the handiwork of girls and adult women.

17. While the whole Austrian exhibition in the educational group was so fine and imposing that the observer felt but little inclined to make comparison of one feature of it with another, it can hardly have escaped the notice of the more critical, that the distinguishing characteristics were, (1) the fulness of the representation of scientific and technical education, and (2) the excellence of the apparatus and other appliance in aid of scientific instruction; some of which were superior to anything to be found elsewhere in the exhibition, if not, indeed, in the world. Among those eminently worthy of such high praise should be mentioned, first of all, the remarkable anatomical preparations of the distinguished Prof. Dr. Hyrtl, of the Imperial University at Vienna. The physical and chemical apparatus, as well as the natural-history collections, on exhibition, were also of unsurpassed excellence; and the extent to which they were found in

the middle and high school sections, as well as in the technical schools section, afforded gratifying evidence of the attention the sciences are receiving in all departments of Austrian education. Art was not less well represented by beautiful models, &c.

The imperial government made many very admirable illustrations of the industrial and social progress of the empire, but no one of them all was to either the patriot or the philanthropist a ground of so much hope for the future of Austria as was this splendid manifestation of the growing interest of both government and people in the advancement of popular education.

18. HUNGARY.—Though not largely represented in Group XXVI, Hungary showed, by the admirable quality of the aids to instruction found in the various sections of exhibition, that she is alive to the subject of education and in the most important respects on the great highway of progress. The text-books in use are modelled very much after the Austrian and German, but the maps of every description, as well as the natural-history collections, anatomical preparations, the models, pictures, &c., used in object-teaching, were excellent.

A visit to the city of Pesth and other portions of Hungary during the progress of the Exhibition gave the writer an opportunity to confirm the favorable opinion formed of the intelligent manner in which the home government of that kingdom is directing the affairs of education.

19. THE BELGIAN REPRESENTATION.—The exhibition made of education in Belgium occupied but small space in the beautiful court of that little kingdom; but the excellence of the articles shown, and the systematic and artistic arrangement of them, commanded the admiration of all visitors.

Conspicuous among the most interesting and instructive exhibits were several handsomely-framed statistical charts, showing the system of education, the amount of aid furnished to the different classes of schools and institutions, and the extent to which the schools are patronized by the public. These were supported by numerous and neatly-bound documents affording fuller information concerning all educational matters.

The most noticeable of the other objects were mathematical forms made of tin, beautiful relief-maps, especially one of Western Flanders, colored blue, with the towns marked by brilliant white spots, very distinctly visible, and a considerable amount and variety of apparatus for perspective and other drawing.

20. The industrial schools were represented by specimens of the work done by pupils; but the primary and secondary schools for general instruction were hardly represented in a manner to warrant the conclusion that the education of the masses of the people was as zealously cared for and enforced as the welfare of society demands.

21. BRITISH INDIA.—It is certainly remarkable that the far-off and less civilized British India should have quite surpassed the United

Kingdom of Great Britain and Ireland in a representation of education at Vienna. To do this required but little effort, however, and it was certainly accomplished; the Indian government sending more than four times as many contributions, and such as better represented the condition and progress of education.

Thus the local board of education of Bengal forwarded various articles used in the schools established for the very young, including specimens of the clothing, bedding, and playthings like those found in the *crèche* of France and the infant-schools of America; also, writing-material and reading-books for little children. The board of Madras sent a collection of writing-tablets, writing-books, the reading and other school books used in the rural districts, in both the native and the English languages, scholars' work, &c. The board of the Northwestern Provinces exhibited astronomical and other instruments in use in the higher schools and colleges, the "Bibliotheca Indica," and other works, and various publications upon education from the government press of the provinces. The board of Berar was represented by books, writing of pupils, charts, globes, and other means of illustration; the board of Mysore by similar objects, and also by reports of the high school of Bengalore; writing in various languages by the scholars themselves, and instruments and apparatus used in the normal school of the province. Numerous other provinces were represented in a very interesting manner.

22. Besides the contributions from many local boards, there were representations from various schools and individuals, a number from the provincial governments themselves, of school and other books published in oriental languages, of reports and public documents.

Among the schools represented, the government colleges in Agra, the school of civil engineering at Roorkee, the normal school in Umritsur are worthy of special mention as giving some idea of the classes of schools in existence in that country.

23. EGYPTIAN EDUCATION.—The representation from Egypt was quite limited in extent, but extremely interesting as coming from a country which, although the cradle of learning and science, has for so many centuries been wrapped in intellectual darkness. The exhibition consisted of a collection of school-books, periodicals, and works upon Egyptian education, statistics of the schools, and accounts of their organization, in the Arabic and French languages; collections of Arabic literature; geographical charts and relief-charts; contributions to the history of the press, and illustrations of Egyptian inventions, as contributions to the history of human industry. Taken altogether, there was just enough of the exhibition from Egypt to evidence the slow awakening of the people of that country from the long sleep by which they have been kept from participation in the grand march of modern civilization.

24. FRANCE.—The remarkable representation made by France at the Paris Exposition, and that fine spirit of emulation so characteristic of

the French people on all occasions of competitive trial, were a sufficient ground of expectation that the French Republic would acquit itself well at Vienna. This expectation was not disappointed. The number of exhibits was 564, only 38 less than at Paris.

The exhibition was not so much a brilliant display as it was an interesting and faithful showing of the system, methods, means, and material appliances of education in France.

Cases filled with the text-books used in all classes and grades of schools; plans and models of school buildings, models without number, and of great perfection, for use in mathematical and art studies; charts in great number and variety and of surpassing excellence; globes, geographical reliefs in plaster, to assist the pupil in gaining correct knowledge of definitions; the most skilfully executed maps, so shaded in color as to give a just idea of the elevation of geographical surfaces; and much beautiful and exquisitely-finished apparatus, philosophical and chemical, with specimens of school-furniture of various kinds. These constituted the very useful and attractive exhibition of French education.

25. An examination of the statistical documents there found revealed to the careful student, however, what any one who has traveled much in France must have observed, namely, that the zeal in education, so noticeable among the more intelligent and liberal of the people, has so far accomplished but little more than to secure the founding and maintenance of a large number of the higher institutions for instruction in the sciences, letters, and the useful and fine arts, and the establishment of schools of excellent quality for elementary and secondary education in Paris and the other cities; that education in the villages and country neighborhoods is far from universal, and is still sadly neglected by general and communal authorities.

Still, there were representations from 93 communal schools, 33 secondary normal schools, and from a very considerable number of schools, male and female, maintained by Christian societies, individual towns, and private persons—in all, over 200 schools, elementary, secondary, and technical. Indeed, the great number of representations from district schools by plans, programmes of studies, and school-work illustrative of proficiency in the various branches taught, was a characteristic feature of the French exhibition. No other nation presented so many.

26. The higher education was also represented, in all its departments, by the programmes, regulations, documents, fac-similes of diplomas, theses, &c., of many university faculties of law, medicine, theology, science, and letters, as well as of special schools of many kinds, including schools of art, of the oriental languages, of the political sciences, of diplomacy, &c. In this particular France also excelled the other countries.

27. THE REPRESENTATION OF THE GERMAN EMPIRE.—Next after the Austrian, the most imposing educational exhibition was the Ger-

man. It occupied a very large building expressly built for it, in the park, by the German government. The building had the form of a Roman cross, the center being occupied by a high trophy of globes and tellurians.

The grouping of articles was according to class and use, and with but little reference to the locality from which they came, so that the visitor found some difficulty in deciding as to the representation of the several countries now constituting the German Empire.

Although this exhibition, as a whole, was attractive to the eye, and contained many objects of great interest and value, it was nevertheless an exhibition far short of what so great an empire, everywhere properly regarded as foremost of the whole world in matters of education, should have made on such an occasion.

28. The apparatus of almost every description was of very excellent design and quality, especially in the physical and chemical departments; the means of illustration, both by natural specimens and by artificial contrivances, were numerous and quite complete; but there was a deficiency of building-plans and models, as well as of reports, statistical charts, and documents, while the display of text-books could hardly be compared with those of this country, either in extent of display, in completeness of collection, or in quality of any sort. Indeed, as to character of text-books, it is a matter of surprise that the nation most advanced in the work of education—the nation in which there is really more of education and culture than in any other—should be so slow to adopt the better methods of instruction furnished by the authors of other countries, and to improve its school-books in various mechanical respects. Badly designed, miserably printed on cheap, coarse paper, and miserably illustrated, the school-books of the German States generally compare very unfavorably with those of our own and still other countries.

29. Among the many interesting objects to be found in the German exhibition were pasteboard models of numerous objects in natural history, especially of the organs of plants and the internal organs of the human body. The botanical models were of large size, so as to be plainly visible from any part of a large class-room, and were fashioned and finished in the most skilful and tasteful manner.

As aids to instruction in drawing, and as a means of art-culture, the German schools are liberally provided with plaster models of noted works of art and of various styles of architectural ornamentation. These, too, were found in this exhibition in great number and variety.

30. In a portion of the building there was an exhibition of samples of newspapers and periodicals to the number of nearly three thousand. They were shingled upon the walls in such a manner as to show the titles, and, until the subsequent exhibition of Mr. Steiger's seven thousand copies of like publications in the American court, were at once a unique and most attractive exhibition.

All in all, the marked features of this representation were the amount and quality of the apparatus and other means of illustration.

31. THE ENGLISH EDUCATIONAL EXHIBITION.—The extreme backwardness of England in all matters of education up to within a very few years past, would have been represented with some degree of fairness by the almost nothing shown by that great kingdom at Vienna. But, in view of the recent awakening in that country, and the vigorous effort now making to rescue it from the deep disgrace of having for centuries done so little for the general education of the masses of its people, it is surprising that no effort was made by the government to insure a fair illustration of the means now in operation for the enlightenment of the too-long neglected masses. The magnificent work done and doing by the Kensington schools of art and industrial design, and the one hundred and twenty-two other schools of art, by the several royal technical and professional schools, the "great public schools," and the universities, would certainly have done much to relieve one of the most prosperous nations of the world, industrially and commercially considered, from the discredit of an apparent total disregard of the educational interest. And then, if to this there had been added a showing of the plans and achievements of the committee of council on education in elementary and secondary education, there would have been a representation of which the friends of English education need not have been ashamed.

32. THE ITALIAN REPRESENTATION.—The educational representation from Italy embraced 220 contributions, many of them from the *real* schools and higher institutions of the kingdom. The *real* schools, (*scuole tecniche*,) of Turin, Asti, Cremona, Mantua, Udine, and some others, exhibited mainly geographical, geodetical, and other charts, reliefs in plaster, drawings, and other work of pupils, and programmes of studies pursued, reports, &c. Besides these there were representations somewhat limited in extent from the royal school of application for engineers at Turin, the superior naval school at Genoa, the superior school of agriculture at Milan, the royal school of paleography and history at Venice; from the royal industrial and professional institutes of Turin and Piacenza, the institute of marine commerce at Naples, the institute of arts and trades at Fermo, and from the other technical schools. There were likewise many exhibitions from normal schools and asylums, as well as from various industrial, scientific, statistical, and art societies, and from local commissions.

The ministers of the interior, of agriculture, of public works, and of public instruction were severally represented by statistical and other documents appropriate to their respective departments.

Among the distinguished individual contributors was Professor Brunette of the university of Padua, who, at Paris, in 1867, made his name conspicuous by his anatomical preparations, and won the applause of the French institute by the generous and manly way in which he gave his secret to the world. His contributions to the Vienna Exhibition were of the same general character.

33. THE NETHERLANDS.—The representation made by the Dutch government was even less considerable than that of Belgium. The government itself was represented by reports and statistics, and various individuals, schools, and educational and industrial societies exhibited documents, text-books, models, charts, &c., illustrative of the character and condition of the elementary, middle, high, and industrial schools of the Netherlands, and of the auxiliaries to instruction in general use therein. But there was no such exhibition made as there should have been in order to do justice to the excellent system and condition of education in a country long characterized by the intelligence of its people, and by their zealous and even heroic devotion to the intellectual and social well-being of the rising generation.

34. THE REPRESENTATION FROM PORTUGAL.—Conspicuous among the school-houses in the exhibition park was a neat-looking, gray, wooden building, marked as the Portuguese school-house. It was a plain, rectangular building, about 36 by 24 feet, with two apartments—one a general school-room, and the other a small ante-room, in which were shown scientific collections for the use of the school, and samples of work executed by the pupils. The furnishing of the school-room was of the antiquated sort, and neither the text-books, the maps, and charts, nor aught else within, gave evidence of an advanced condition of education. Evidently, the Portugese have much to learn in the matter of means and methods.

35. THE SPANISH REPRESENTATION.—The enterprise shown by the Spanish government, at Paris, in 1867, warranted the expectation that under ordinary circumstances, that ancient kingdom would be again well represented. But it was hardly anticipated that, in the midst of revolutions and internecine war, the government of Spain would turn aside to mingle her contributions with those of the other nations in a competitive showing of her resources and progress. For sufficient reasons, she was quite late in arranging and opening her educational department; but when she finally did so, the multitude of her contributions, and the pleasing manner in which they were displayed, afforded gratification even to those who must, of necessity, criticise her adherence to absolute methods and instrumentalities still in use in her public schools, or, at least, in very many of them.

The number of contributions was 434. Few of them were collective, however. For the most part, indeed, they were simply of one or two articles, as of single works by authors, programmes, or reports from individual institutions, or the director thereof. But they were nevertheless interesting and useful, as showing the educational status of a people characterized, to a marked degree, by the extremes of high culture and abject ignorance. Spain has been slow in learning the vital importance of educating the masses of her people.

36. THE SWEDISH REPRESENTATION.—Sweden made 994 entries in all, and of these 240 were in the educational group—a fact fairly illus-

trating the great importance attached to the training of youth in that country.

37. First in magnitude and attractiveness was the neat little Swedish school-house, in which the educational exhibits were placed. This building was constructed in every part in Sweden and afterward put up in the exposition park by Swedish mechanics. It was built with the utmost care, therefore, and being of native timber and varnished so as to show the character of the wood, it attracted great numbers of interested spectators, most of whom gave it the palm for neatness of appearance as well as for pleasantness and adaptation to use. It had more the look of a residence than of a school-house, as, indeed, it was. For in Sweden the school house is generally also the home of the teacher and his family. In fact, this specimen was a handsome two-story cottage, consisting of a main part with end to the front or street, and another part built at right angles to the first, with a little portico at the angle of their junction, from which portico the entrance was made to the school-room. The school-room was beautifully lighted, though on but two sides, the light so falling upon the pupil's work as to give him the whole benefit with as little injury from glare of excessive light as possible. The seats, though rather rudely designed, were neatly made and to the Swede were apparently the most perfect that could be contrived; and this notwithstanding the seat proper was of a simple board, slightly inclined backward, and with a straight board, also inclined, for the back.

38. In one respect the seats and desks, which were attached, were indeed worthy of imitation everywhere: each was designed for a single pupil, as were those in the American school-house. Cases in the room contained several pieces of neat, though simple, apparatus; the walls were hung with excellent maps, charts, and tablets illustrative of geography and natural history. Cases wholly of glass contained numerous specimens of the more important insects of Sweden; racks supported music-charts; and at the side stood guns and instruments of martial music for the use of students in the military drill, which is as much a feature of the common school in that country as it is coming to be in the endowed technical schools of this.

The wall-maps were numerous, and were so arranged upon a rolling-apparatus that they all occupied but the space of one, and could be drawn down or up in a moment.

Opening out of the school-room, near the teacher's platform and desk, was a small apartment containing the *people's library* of the school district. Several hundred volumes of standard authors and books of reference, all in neat and quite uniform binding, presented an attractive appearance, and seemed to illustrate how in more than one way the people of the rural district or small village are bound to the school. The remainder of the building, though designed for the teacher's family, was occupied for exhibition purposes on this occasion, and contained many articles of interest, such as models of various kinds, furniture, appara-

tus, and work done by pupils. Passing from the Portuguese school-house, not far away, into the Swedish, was like entering a new world and breathing a new atmosphere. In the former country the love of knowledge has not been awakened in the minds of the masses; in the other, it is a moving influence and governing power.

39. SWITZERLAND AT THE EXHIBITION.—The representation of Swiss education was, of course, among the most interesting of all that were made. For, besides the fact that the people of that little republic are a part of the advance-guard in matters of education, it is also noteworthy that they are among the most enterprising of all the peoples of Europe, and lose no opportunity to contribute to the social progress of the world.

The exhibits belonging to Group XXVI were shown in an attractive little *chalet* in the southern portion of the park. They were contributed in large part by the federal department of the interior, and by the educational boards (*erziehungs-directionen*) of various cantons, including especially those of Bern, Zurich, Turgau, Basel, Genf, Tesino, Nuremberg, Wandt, and Aargau.

The interior department exhibited the official documents of different branches of the government, and numerous publications of the statistical society of Switzerland, and of the Swiss meteorological, geodetical, hydrometric, and geological commissions. The cantonal boards of education made interesting contributions of reports, plans of school-buildings, text-books used in the parish, bezirk, and cantonal schools of different grades, programmes of study, furniture, apparatus, maps, charts, &c. Besides these there were exhibitions of great interest by various societies and clubs of a literary and scientific character, as well as by numerous individual contributors.

40. The distinguishing feature of the Swiss educational exhibition was the excellent quality of the text-books shown; the extraordinary quality of the maps, charts, and reliefs in plaster and pasteboard, for instruction in geography, and the numerous illustrations it afforded of the zeal and enthusiasm of teachers and pupils, especially in the scientific departments of study. The purpose is that each school shall have its scientific collections, and that each pupil shall also, for himself, make collections and observations as he goes on with his studies. In this way each student incidentally becomes a naturalist or physicist, according to the bent of his mind, and the whole body of schools so many recruiting centers for the several scientific corps of the republic.

41. THE TURKISH REPRESENTATION.—But little was expected of Turkey, and but little of real value, as showing the condition of education in that country, was exhibited. Nevertheless, there were 67 contributions from Turkey proper, and 95 from the provinces. Over 30 of the former were from an equal number of boys' and girls' schools of the different grades known in that country. A large proportion of the exhibits were specimens of the handiwork of pupils in some branch of

industry or art. There was almost nothing in the way of reports or statistical statements from which one could get a knowledge of the condition of education, unless, as seems legitimate, this fact of itself be accepted as proof that, as yet, there is for the great body of the people only the most elementary and superficial instruction.

42. OTHER NATIONS.—The representations from Denmark, Norway, Russia, Roumania, Greece, and China were so entirely insufficient as a means of conveying any just idea of the condition and progress of education in those countries that they furnish no warrant for more than this mere mention of the delinquency.

CHAPTER III.

WORK OF THE JURY.

CONSTITUTION OF THE JURY FOR GROUP XXVI; LIST OF JURORS; ORGANIZATION; AWARDS; LISTS OF AWARDS.

43. The International Jury for education consisted of a president, two vice-presidents, and forty other members, assisted by nine substitution members (*ersatz männer*) and two experts. The presidency and the two vice-presidencies were assigned to the countries accorded them by order of the Imperial Commission, and the officers themselves were appointed by that commission on the nomination of the authorized governments, respectively. The jurors in general were chosen by the national commissions from the countries represented in the group, with the approval of the Imperial Commission. The number that could be named by any country was determined by the number of exhibitors represented in the group, ten exhibitions entitling a country to one juror, one hundred to a second, two hundred to a third, and so on.

44. The following are the names of the persons who composed the jury and of those who were designated by the Imperial Commission to assist them in the discharge of their duties:

President.—John W. Hoyt, Honorary Commissioner, &c., Wisconsin, United States of America.

Vice-Presidents.—Landammann Dr. F. Von Tschudi, St. Gallen, Switzerland.

Dr. Carl Rokitansky, Imperial Councillor and University Professor, President of the Imperial Academy of Sciences at Vienna, &c., Austria.

Jurors.—Mr. M. Achtner, Imperial Public-School Inspector in Prague, Austria.

Señor Don Antonio Aguilar y Vela, Director of the Astronomical and Meteorological Observatory at Madrid, Spain.

M. Alvin, member of the Royal Academy, Belgium.

Señor Don Emilio Arrietta, Director of the National School of Music at Madrid, Spain.

Count de Benalcanfor, Portugal.

Madam Bergström, *née* Sjöcrona, wife of His Excellency the Minister of the Interior, Sweden.

Signor Bonghi Comm. Ruggero, member of the National Parliament, professor in the University of Rome, and member of the Superior Council of Public Instruction, Italy.

Dr. Bornemann, Counsellor to the Royal Minister of Education at Dresden, Saxony.

Señor Don Mariano Carderera, formerly Inspector-General of Primary Instruction, Spain.

Dr. Alois Czédik von Bründelsberg, Director of the Academy of Commerce at Vienna, and manager of the Western Railway, Austria.

M. Albert Dethomas, France.

Dr. Rudolph Eitelberger von Edelberg, Imperial and Royal Councillor and Director of the Imperial Museum of Art and Industry at Vienna, Austria.

Dr. J. J. da Franca, jr., Brazil.

Rev. J. G. C. Fussell, Her Majesty's Inspector of Schools at London, Great Britain.

Dr. Don Antonio Maria Garcia Blanco, Professor in the Central University, Spain.

Mr. Paul von Gönczy, Department Commissioner, Hungary.

M. Gréard, Inspector General of Public Instruction, Director of Primary Instruction for the Department of the Seine, France.

Dr. Constantin Ritter von Höfler, Professor in the University at Prague, Austria.

Dr. Joseph Hyrtl, Imperial Royal Councillor and Professor in the University at Vienna, Austria.

M. le Baron M. de Königswarter, former member of the Corps Legislatif, France.

M. Lefébure, member of the National Assembly, France.

Professor von Leins, of the Royal Polytechnic School at Stuttgart, Würtemberg.

M. Levasseur, Professor in the Collége de France, member of the Institute, France.

Dr. G. A. Lindner, Director of the Normal School in Kuttenberg, Austria.

Dr. Carl von Lützow, Austria.

Mr. Alfred Molnar, Royal Hungarian Sections-Councillor in the Ministry of Public Instruction, Hungary.

Dr. Salomon Hermann Ritter von Mosenthal, Imperial Government Councillor and Librarian to the Ministry of Worship and Education, Austria.

Dr. J. D. Philbrick, Superintendent of the Boston Schools, Honorary Commissioner, United States of America.

Dr. Franz Joseph Pisko, Director of the Imperial Real-School in Sechshaus, Austria.

M. Eugen Rambert, Professor in the Federal Polytechnic School at Zurich, Switzerland.

Rev. Prebendary Rogers, London, Great Britain.

M. Fr. Sandberg, Rector of the Teachers' Seminary in Stockholm, Sweden.

Mr. Schwammel, Imperial Inspector of Schools, Austria.

Dr. F. Seelheim, of the High Burger School in Hiddelburg, Netherlands.

Señor Don Francisco Maria Tubino, Spain.

Dr. Urlichs, Government Councillor, Professor in the University of Wurzburg, Germany.

Mr. Velliarminöff, member of the Scientific Committee of the Ministry of Education, Russia.

Mr. Joseph Weber, Imperial School Councillor in Prague, Austria.

Mr. Vincenz Weninger, General Director of the General Credit Bank in Pesth, Hungary.

45. The jury was organized on the 16th day of June by the choice of Dr. S. H. Ritter von Mosenthal, Imperial Councillor, as Secretary, and Dr. Alois Czédik von Bründelsberg, Director of Handels Akademy, as reporter, and by the organization of four sections of the jury for the more convenient and efficient discharge of its duties, to wit:

(1.) The section of primary education.

(2.) The section of intermediate, or lower secondary, education.

(3.) The section of higher education, including technical and professional schools and universities.

(4.) Instruction in the more limited sense—literature, the press, libraries, and educational societies.

The work of inspection was done by these sections, each of which included such members as chose to be assigned to it; and the conclusions reached by each section after examinations, re-examinations, and discussions at the meetings, which were here almost daily, were finally reported to the whole jury, which, during repeated and laborious sessions, took up the propositions submitted by the sections in systematic order, discussed, and disposed of them. In cases where satisfactory conclusions could not be reached, new examinations were made, and, if necessary, repeated until it appeared reasonably certain that justice had been done.

46. On the 31st day of July the record was made up, and soon after submitted to the council of presidents, consisting of the presidents, vice-presidents, and reporters of all the juries, for the settlement of any questions of principle, as well as for approval or rejection of all proposition toward the grand diploma of honor, and for final return to the Archduke, President of the Imperial Commission.

The writer is able to speak from personal knowledge of the laborious and faithful manner in which the members of the educational jury discharged the arduous duties assigned them; many of whom gave the entire six weeks, with scarcely a day's interruption, and six to eight hours per day, of the most careful and conscientious labor, to their duties. The results of this effort, so far as it appears from the record of their decisions, will be found in the following table of awards:

Comparative statement of awards in Group XXVI.

Country.	Designation of awards.					Total number of awards.
	Diploma of honor.	Medal for progress.	Medal for merit.	Medal for coöperators.	Diploma of merit.	
America	4	7	23	1	18	51
Austria	4	34	81	2	112	233
Hungary	1	3	9	......	33	46
Belgium	1	4	9	......	11	25
Brazil	......	......	3	......	4	7
China	......	......	1	......	......	1
Denmark	......	1	2	......	3	6
Egypt	......	1	2	......	2	5
France and colonies	2	18	40	2	87	149
German Empire	14	32	52	5	82	185
Great Britain	......	1	2	......	4	7
Colonies	1	......	2	......	11	14
Italy	2	8	28	2	45	85
Japan	......	......	......	......	1	1
Netherlands	1	3	3	......	2	9
Norway	......	......	......	2	1	3
Paraguay	......	......	1	......	......	1
Persia	......	1	......	......	1	2
Portugal	......	1	4	......	9	14
Roumania	......	......	1	......	......	1
Russia	......	6	4	......	7	17
Sweden	1	4	11	2	16	34
Spain	......	5	20	2	43	70
Switzerland	3	13	12	......	14	42
Turkey	1	......	4	......	2	7
Total	35	142	314	18	508	1,017

47. In view of the incompleteness of the American exhibition in this group, it is gratifying that so large a number of prizes should have been accorded to it; that a group from which but little was at first expected, in fact ranks foremost in the number of awards, securing about one-fifth of all the prizes accorded to the American department, and even one-half of the whole number of diplomas of honor.

48. The following is a full

LIST OF THE AWARDS MADE TO AMERICAN EXHIBITORS IN GROUP XXVI.

Grand Diplomas of Honor.

The National Bureau of Education, Washington, D. C., for distinguished services in the cause of education, and for important contributions to the Exhibition.

The State of Massachusetts, for valuable reports and documents, and for the enterprise shown by its organized personal representation at Vienna.

The city of Boston, for the full and complete illustration of its school-system and schools.

The Smithsonian Institution, Washington, D. C., for its efficient labors in the advancement and diffusion of knowledge.

Medals for progress.

Guyot, Professor, Princeton, N. J.: wall-maps.

Howe, Dr. S. G., Boston, Mass.: publications for the blind.

National Educational Association, successful efforts in promoting the advancement of education.

Ohio State department of public instruction, T. W. Harvey, commissioner, Columbus, Ohio: school-reports, statistics, and other contributions.

Prang, L., & Co., Boston, Mass.: chromolithographic illustrations of natural history.

Washington, D. C., J. O. Wilson, superintendent: progress in education and in school-architecture.

Medals for merit.

Appleton, D. & Co., New York: wall-maps.

American Printing-House for the Blind, Louisville, Ky.: books for the blind.

Astor Library, New York.

Barnard, Dr Henry, Hartford: American Journal of Education.

Brewer & Tileston, Boston, Mass.: school-publications.

Chicago public schools, J. L. Pickard, superintendent: school-reports, examination-papers, and statistics.

Cincinnati public schools, John Hancock, superintendent: reports, examination-papers, and statistics.

Cooper Union, New York: useful labors in the interest of the working-classes.

Cowperthwait & Co., Philadelphia: Warren's wall-maps and books.

Grossius, John, Cincinnati, Ohio: patent ventilating school-house stove.

Harper Brothers, New York: school-books, school slates, tablets, and charts.

Lea, H. C., Philadelphia: medical text-books, American Journal of Science.

National School-Furniture Company, New York: school-furniture.

New York City department of public instruction, Professor Kiddle, superintendent: school-books, school-reports, photographic views of schools, and specimens of school-work.

Ross, Joseph L., Boston, Mass.: school-furniture.

Schedler, Joseph, Jersey City Heights, N. J.: terrestrial and celestial globes.

Steiger, Ernest, New York: seven thousand specimens of different American newspapers and periodicals published in 1873, bound in 130 volumes; also school-books in the German language.

Toner, Dr. J. M., Washington, D. C.: collection of reports of medical institutions and hospitals of the United States.

Wait, William B.: educational apparatus.

Wheeler & Wilson Sewing-Machine Company, New York: for the establishment of schools for the instruction of the poor in needle-work.

Wilson, Hinkle & Co., Cincinnati, Ohio: school-atlases and other school-publications.

Medals for co-operation.

Woods, J. O., New York: co-operation in promoting the establishment of schools for gratuitous instruction in needle-work.

Diplomas for merit.

Baltimore, Md., public schools: reports of the board and superintendent, examination-papers in departments of writing and drawing.

Barnes, A. S. & Co., New York: school-publications.

Bridges, Lyman, Chicago: construction of American school-house.

Canton City, Ohio: school-reports and examination-papers.

Cleveland, Ohio, public schools, A. J. Rickoff, superintendent: school-reports and school-work.

Dayton, (City of,) Ohio: school-reports and examination-papers.

Enthoffer, J., United States Coast Survey: charts, &c.

Fremont, Ohio, public schools: school-reports and examination-papers.

Leeds, Lewis W., New York: drawing for ventilation and heating of school-houses.

Lippincott, J. B., & Co., Philadelphia: school-publications.

Lowell Institute, Boston, Mass.: promotion and dissemination of useful knowledge.

Newton, (town of,) Mass.: school-reports and school-statistics.

Scribner, Armstrong & Co.: publication of Guyot's maps.

Shattuck, G. M., Boston, Mass.: school desks and seats.

Springfield, Ill., public schools: school-reports, examination-papers, and statistics.

Toledo, Ohio, public schools, D. F. De Wolf, superintendent: school-reports, statistics, and examination-papers.

Worcester City, Mass., schools, A. P. Marble, superintendent: school-reports, statistics, school-work, and photographs of school-buildings.

CHAPTER IV

RESULTS OF EDUCATIONAL REPRESENTATION.

VALUE OF EXAMPLE AND COMPETITION; PRINCIPLES AND METHODS; IMPORTANCE TO THE UNITED STATES; DEFICIENCIES OF AMERICAN EDUCATION.

49. The human mind is so constituted as to need the stimulus of both example and emulation. The knowledge of mental activity and inventive genius gained from consciousness, merely, would come as nearly as possible to none at all. But responsive effort at home, and the tidings of kindred thoughts and labors in other lands, how wonderfully do these awaken thought, quicken invention, and multiply craft! What, then, might not be the result of having a fitting representation of the thought and skill of each nation ushered into a well-organized exhibition of the products of the genius and labor of the world? Such an opportunity was that presented and accepted by the nations on occasion of the late Universal Exhibition of 1873.

It is hardly possible that the present generation should have an adequate conception of the influence of this great event. As is the case with all great events, it will be best comprehended in the light of those that follow it.

This estimate being a correct one, as applied to the whole Exhibition, with its suggestive and stimulating influence upon all the arts and sciences, how much more is it true of the educational interests; affording, as the exhibition did, the best opportunity the nations ever had of looking into each other's school-houses, and of seeing for themselves what each was doing for the education of its youth.

50. There has been much coincident thought on the subject of education among civilized nations. The ground gone over, and, in many respects, the methods adopted, have been similar. Nevertheless, the isolation of most countries previous to modern improvements in transportation, and the diversity of language, notwithstanding this, have made an exchange of thoughts more difficult than that of material products. Commodities, the speech of commerce, have access to all peoples through the avenue of the senses and of universal want, always ready for barter; but the *thoughts* of the millions, reaching out after knowledge and the sympathy of fellowship, must compass those more precious ends by the slow and difficult mastery of unknown tongues.

Because of this, the mistakes of false methods have repeated themselves, and where breadth and insight have advanced the culture of a people, other peoples have not soon profited thereby. Hence the more

need that the educational systems and methods should have such means of comparison as were here offered.

In connection with this direct advantage there was the incidental one of having the entire display arrayed on the side of educated industry of whatever sort. Everywhere was this superiority seen and felt. And to the ends of the earth it is moving to a reconstruction of labor and society.

In all countries where the spirit of caste has held the masses in ignorance, and hence in bondage, to the few, this fact, that an educated industry is the *sine qua non* of profitable investment, is working a foregone enfranchisement. Land cannot always be held from the ownership of the class who understand the secret of its successful tillage, nor self-government from those who take disciplined hands and ideal freedom into the world of design. Intelligent and progressive labor is everywhere and always the body of liberty. And by this consecration of labor to noble and ever-advancing ends, the soul of liberty to be and do becomes incarnated and reveals itself in society.

To both the Old and New World, the voice of this great occasion made common message: educate! educate!

51. To the United States this message comes with especial significance, or ought so to come. In presence of the art and industries of the world we had occasion to learn the lesson of more modest estimates of our own, and more appreciative ones of the accomplishment of other nations. Seeing is believing; and believing ourselves behind our neighbors in any honorable achievement ought to be coincident with a resolute purpose to amend this at the earliest possible moment. That we are behind some other countries, in both education and industry, was a demonstration made by the Vienna Exhibition.

More closely stated, it is in respect of organized and systematic education and industry that we are behind. And this, indeed, is the principal reason why our general representation there was so small and so unrepresentative.

National as well as individual credit comes of utilized opportunity; and the furtherance of either in real greatness is very dependent on a frequent and severe self-scrutiny. Face to face with the pretty fairly rendered account of the world, it was a more fitting time than ever before presented for a national reckoning. Our country was the youngest of any of the great powers in attendance, and had this mitigation of the fact that we were the most unworthily represented of all having anything like our resources and capabilities. But this excuse will not serve us again. The present age is so remarkable in development that a year of it is as a hundred of such as belonged to the ages past. Incomparably more marvellous should be the future development of a country so young, so strong, so rich, and so untrammelled as ours. We have unoccupied territory for the planting of all forms of art and for the best artisans now foreign to our shores. There is scarcely anything

useful or beautiful for which we have not material in abundance. We have millions of people, with ability to secure the leadership in anything undertaken with that intent. We dictate the government, form our institutions, and fix the terms of our own security. We are, moreover, in the vigor of youth and in the freshness of our purpose to show the world our hand.

52. Unhappily, two mischiefs intervene; possibly three:

We do not yet know, not very generally, that we are an uneducated people—uneducated in the schools and in the industries. This is a hard statement and unwelcome to this generation. Let those who doubt it go to the records. Education is here used, of course, in a relative sense. We have no *adequate* education, none which for thoroughness compares with that to be found abroad.

We are, moreover, impatient of results. Most tardy of engraftment upon the national character will be the virtue of patience. With rare exceptions, the American scholar and the American artisan know little of the luxury of a labor that begins in necessity and through thoroughness gives mastery.

It is barely possible that a third difficulty in accepting and profiting, to the full extent, by great occasions and times, comes of a less than thoroughly just estimate of labor itself. Let us hide the blush of shame at thought of this behind the fact that it is not affirmed, only suggested.

"Showing the world our hand." Let us consider well what this imports, and see to it that the American mind does not accept a restless and impatient activity for an honest and competent industry. We are preparing to sit down for a summer's day in the glorious memories of a century just passed away. If the incoming century could bring with it a full awakening of the public mind to that most pressing of all our needs, the universal education of our people would be as good as accomplished. For what are ways and means to a people who, when they feel their need of anything, straightway get it?

It can hardly be doubted that the half-doing at Vienna what ought to have been done thoroughly has contributed something to the progress of education throughout the world. Should it also be the means of the nation's doing itself anything like full justice at Philadelphia in 1876, it will have indirectly accomplished a great work.

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M.

DEAF-MUTE INSTRUCTION.

E. M. GALLAUDET.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

DEAF-MUTE INSTRUCTION.

BY

E. M. GALLAUDET.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

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DEAF-MUTE INSTRUCTION AS REPRESENTED IN THE VIENNA EXHIBITION OF 1873.

1. The defective arrangement of the Exhibition, markedly inferior to that of Paris in 1867, rendered it difficult to make a comparative examination of exhibits of a similar character from different countries.

This was true in an especial degree of the matter of deaf-mute instruction; that is to say, it was almost impossible to be certain one had discovered, even after long search, all that might exist in the Exhibition relating to this specialty in the departments of education or public charities.

2. For the credit of the several states of Europe where establishments for deaf and dumb exist, it is to be hoped that the following report may be found to be imperfect, and that much more than we were able to discover met the eyes of observers more fortunate than ourselves. Otherwise, the fact will pass into history that, of the hundreds of institutions in Europe, but five, and four of these in Austria, contributed anything to the *Welt-Ausstellung.*

From the imperial royal institution in Vienna, a set of photographs appeared, showing with considerable clearness the arrangement of its buildings.

From the institution at Brünn, specimens of steel pens manufactured in the establishment, together with some other unimportant articles of handiwork, were exhibited.

The St. Polten school sent a series of picture-cards used in teaching beginners; and the institution at Gratz presented wood-carvings, executed by its pupils, fancy work, shoes manufactured in the institution, and specimens of penmanship.

3. In marked contrast to this meager presentation from the schools of Europe was the collection of reports, photographs, and publications to be found in the American department.

Early in the autumn of 1872, the honorable Commissioner of Education, General John Eaton, requested Prof. Edward A. Fay, then acting president of the National Deaf-Mute College and editor of the "American Annals of the Deaf and Dumb," to invite institutions for deaf-mutes in the United States to send "as full representations as possible of the methods and results of the education of the deaf and dumb in America."

4. In response to Professor Fay's invitation, there were forwarded, through the Bureau of Education, and exhibited in a prominent section of the space allotted to the United States, the following contributions:

From the American Asylum at Hartford, Conn., a complete set of reports, 1817–'72, bound in four volumes; and the discussion on articulation before a committee of the Massachusetts legislature in 1867, one volume.

From the Pennsylvania institution, located at Philadelphia, a volume of reports and a photograph of the buildings.

From the Indiana institution, situated at Indianapolis, a complete set of reports, 1844–'72, in two volumes; and the proceedings of the seventh convention of American instructors of deaf-mutes.

From the Iowa institution, located at Council Bluffs, a volume of reports, and a photograph of the buildings.

From the Texas institution, located at Austin, a complete set of reports, 1857–'72, in one volume.

From the Columbia institution, located at Washington, D. C., a complete set of reports, 1857–'72, in one volume, including proceedings of conference of principals in 1868, and a portfolio of photographs of buildings.

From the Minnesota institution, located at Faribault, a complete set of reports, 1863–'72, and a photograph of the buildings.

From the Clarke institution, located at Northampton, Mass., a complete set of reports, 1867–'72, in one volume.

From the National Deaf-Mute College, Washington, D. C., a complete set of catalogues, 1864–'72, in one volume.

From the American Annals of the Deaf and Dumb, a complete set of its publications, bound in eight volumes, and comprising the quarterly issues of seventeen years.

From the Silent World, a complete file, bound in one volume.

Besides these publications, which were in position to be examined by visitors early in June, we were informed that at a later date the following contribution was sent from the New York institution: Annual reports, from the seventeenth to the fifty-fourth, inclusive, 1835–'72, bound by deaf-mutes; H. P. Peet's Course of Instruction for the Deaf and Dumb, in three volumes; H. P. Peet's Scripture-Lessons for the Deaf and Dumb; H. P. Peet's History of the United States; I. L. Peet's Chart of Predicates of the English Sentence, representing, by means of symbols, the various forms these predicates are capable of assuming.

5. To those familiar with the work of deaf-mute instruction in this country, the mere mention, by title, of the foregoing publications will sufficiently indicate the value of the collection. For the information of the general public, however, it is proper that some further explanation should be given.

In the official reports of the several institutions named, the leading facts in the history of deaf-mute instruction in this country are recorded; statements in detail of the cost of buildings and of current expenses are furnished; much valuable statistical information as to causes of deafness, &c., is afforded; methods and courses of instruction are

explained and set forth; discussions in teachers' conventions are reported; results of examination and specimens of pupils' composition are given as indices of progress; and the legislation of State and Federal Governments is published. The volume of catalogues and announcements of the National Deaf-Mute College, 1864–'72, gives an account of the organization of this institution, states its objects, the courses of study pursued, the names of its officers and students, the degrees it has conferred, and many other items of interest.

6. The publication of the "American Annals of the Deaf and Dumb," was undertaken in the year 1847, as a private enterprise, under the auspices of the instructors of the deaf and dumb in the American Asylum located at Hartford, Conn. After having been sustained in this form for two years, the periodical was adopted, in 1850, as the organ of the convention of American instructors of the deaf and dumb, which held its first menting at New York in that year. For eleven years, its publication was continued at Hartford; under the editorial direction of Luzerne Rae, for four years; and for seven years under that of Samuel Porter, both instructors in the institution at Hartford. The latter is now a professor in the National Deaf-Mute College at Washington. Suspended in 1861, on account of difficulties growing out of the war, it was revived by the action of the conference of principals, held at Washington in May, 1868. Since that time, it has been published in Washington, for two years, under the charge of Llewellyn Pratt, followed by the present editor, Edward A. Fay, both professors in the National Deaf-Mute College.

The object and scope of this important publication are stated in the "Introductory" to the first number, that of October, 1847, as follows:

"We intend that the range of discussion taken by the Annals shall be as wide and varied as the unity of our purpose will allow. The deaf and dumb constitute a distinct, and in some respects strongly-marked, class of human beings, and a much more numerous one than is commonly supposed. They have a history peculiar to themselves, extending back for many centuries into the past, and sustaining relations of more or less interest to the general history of the human race.

"With our utmost diligence, we propose to seek after whatever stands connected with this particular history of the deaf and dumb, to gather up its *disjecta membra*, for it exists as yet only in a fragmentary state, and to set it forth with such distinctness and completeness, that whoever shall hereafter desire to ascertain any fact or resolve any doubtful question concerning this class of persons, may find something in our pages to aid him in his search.

"Among the particular points of inquiry to which our attention will be directed, the following may be mentioned as likely to occupy a prominent place: Statistics of every kind relating to the deaf and dumb; their social and political condition in ancient times; the history of the first attempts made to instruct them, and of the progress of the art down to the present day; a particular historical sketch of each of the

institutions for the deaf and dumb in this country, with more brief and general notices of those in foreign lands; a careful exposition of the philosophy of the language of signs; biographical sketches of individual deaf-mutes who, for any reason, may be thought worthy of such distinction; notices of books relating to the instruction of the deaf and dumb, with particular reference to their comparative merit; a survey of the state of the deaf and dumb mind before education, illustrated occasionally by articles from the most intelligent of the deaf and dumb themselves; some account of our method of instruction, intended as a practical guide to those who have deaf and dumb children; a history of attempts made to teach articulation, with the processes pursued and the results attained; something in regard to diseases of the ear, and the efforts made by physicians for the cure of deafness; an inquiry into the relations which the instruction of the deaf-mutes bears to that of hearing and speaking children, and the mutual benefit to be derived from a comparison of the two methods; in short, we mean that our American Annals shall constitute, when completed, a perfect treasury of information upon all questions and subjects relating either immediately or remotely to the deaf and dumb.

"The contents of the Annals will consist of original articles, principally prepared by individuals who are at present engaged in the instruction of the deaf and dumb at the various institutions in this country. Occasional contributions we hope to receive, however, from gentlemen of other professions; and, as soon as the necessary arrangement can be made, we expect to open a regular correspondence with a few of the most prominent establishments of this class in foreign lands. The articles furnished for our pages will be of various length and character, adapted always in these respects to the nature of the subjects discussed, and approaching nearer to the peculiar style of the lively magazine than of the formal quarterly. Special effort will also be made to present whatever we may have to say in such a manner as to interest, not the deaf and dumb alone, and their parents, friends, and instructors, but every general reader who has any heart to sympathize with the benevolent operations of the age, or any desire to make himself acquainted with human nature in all the forms of its manifestation and development."

The purposes thus announced by the first editor have been measurably fulfilled, and the eighteen volumes now completed present a most valuable series of articles relating to the instruction of the deaf and dumb. They include, in fact, the greater part of the literature of our profession in the English language, excepting, of course, text-books, and are almost indispensable to any who wish to acquaint themselves with the art of instructing the deaf and dumb, its history and its theories, especially to those who would become successful teachers.

This periodical has never been published with a view to pecuniary profit. The responsibility of its support has been assumed by the sev-

eral State institutions, the expense being distributed *pro rata* in proportion to the number of pupils in each.

7. The "Silent World" is a semi-monthly newspaper, published at Washington, D. C., under the editorial direction of J. Burton Hotchkiss a tutor in the National Deaf-Mute College. It is designated for circulation among educated deaf-mutes and their friends, and aims to strengthen the ties which bind the graduates of our institutions to their teachers and school-mates; to keep the deaf and dumb well acquainted with the progress that is constantly being made in the systems of instruction; to furnish a medium for the discussion of new theories and practices by the deaf-mutes themselves, as well as by their friends; in short, to minister to their pleasure, to instruct, aid, elevate, and refine, and give others an insight into the *silent world* of the deaf, their education and capabilities.

8. Since returning to America, we have learned that there were sent to the exhibition, from the institution at Friedberg, Hesse, specimens of handiwork of female pupils; also, a complete set, in nine volumes, of the "*Organ der Taubstummen und Blindenanstalten in Deutschland*," a monthly publication, which has been conducted for nineteen years by Dr. Matthias, the principal of the Friedberg institution; also, certain other publications by the same author.

9. It is difficult to say what effect for good may result from the presence at Vienna of the several publications we have now described.

Our duty is performed in reporting the extent to which the interest of deaf-mute instruction was represented in the exhibition.

We may, however, be permitted to express the hope that the record of what has been done in the United States of America may be allowed to exert such an influence as shall serve to stimulate effort in behalf of this important educational interest in countries where much less has been accomplished, relatively, than in our own land.

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N.

GOVERNMENTAL PATRONAGE OF ART.

E. M. GALLAUDET.

VIENNA INTERNATIONAL EXHIBITION, 1873.

GOVERNMENTAL

PATRONAGE OF ART.

BY

EDWARD M. GALLAUDET.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

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GOVERNMENTAL PATRONAGE OF ART.

1. INTRODUCTION.—An act of Congress, approved February 14, 1873, sets forth as its object the enabling of "the people of the United States to participate in the advantages of the international exhibition of the products of agriculture, manufactures, and the fine arts, to be held at Vienna in the year 1873."

The process by which this participation is to be accomplished would perhaps appear, at first thought, to be limited to the preparation of descriptive reports, more or less fully illustrated by means of photographs or drawings of articles presented for exhibition.

But, we take it, the work of the Commissioners is not restricted to the narrow bounds of mere description. A single visit to the Exhibition can hardly fail to give rise to suggestions of a general nature, the dissemination and discussion of which may serve to stimulate and advance particular interests.

Acting upon this presumption, we venture to present some considerations upon a subject which was forced upon our attention at very many points while threading the labyrinth of the *Welt-Ausstellung.*

As our eyes rested in succession upon the paintings, sculptures, bronzes, porcelains, and other works of art which embellished the Exhibition in almost bewildering numbers, we could not fail to notice that to very many of the more beautiful productions labels were attached, indicating that they had been already purchased, although but few weeks had passed since the opening of the Exhibition.

2. We observed the names of museums at St. Petersburg, Berlin, Vienna, Munich, Edinburgh, Nuremberg, Moscow, and other places as purchasers, besides those of individuals, who, it was well understood, were buying for the governments of the several countries of which they were citizens or rulers. In this lay the suggestion of a method of enabling the people of distant countries "to participate in the advantages of the international exhibition" quite different from that afforded by descriptive and even richly-illustrated reports.

Although the legislation of Congress may secure for the people of our country, through the medium of these reports, much that will be of value as regards the industries and so-called practical arts, it is evident that the department of the fine arts must remain practically a sealed book to all Americans who were not present at Vienna to see it for themselves.

3. While the governments of Europe have secured works of great

merit and value, as illustrating not only pure art, but art in its applications to industry, which, in their museums, freely open to the public, will enable their people to participate in this beautiful feature of the Exhibition, and serve as perpetual models of taste in the fine arts, the Government of the United States has, by its failure to provide the means for similar purchases, effectually cut off its people from any *such* participation in the advantages of this Exhibition.

The loss thus sustained cannot easily be estimated. But the lessons of neglected opportunities may be accepted by nations as well as by individuals; and while lost occasions may not be regained, those who have suffered by permitting them to pass unimproved may make themselves ready to profit by what the future shall present. And if, in a subject so important as the one we are considering, the losses entailed by the inadvertence of Congress can be made to appear so evident as to induce the adoption of wise measures on the part of the Government for the future, the error of the present may, in some degree at least, be compensated for.

Many persons to whom the subject of governmental patronage of art, as connected with the United States, may be presented, will doubtless object at once that the patronage of art forms no part of the duty of the Federal Government; and some will even go so far as to urge that the adoption of measures to this end would be in violation of the Constitution. Leaving all questions of constitutionality and legal ability to be settled by those whose duty it is to consider and dispose of them, our national legislators do not need to be reminded that the Constitution of the United States was made by and for the people, and not they by and for the Constitution. And if, as has already appeared in the progress of our national civilization, the provisions of organic law adopted a century, more or less, ago, may be profitably amended, it is by no means a conclusive argument against a proposed governmental policy or measure that it is unconstitutional.

We will not, however, even consume time and space in this paper by discussing the question, separately, whether the Federal Government ought to become the patron of art; in reference to which, however, we hold to a very decided affirmative.

We prefer to base our claim, to make the subject a practical one in connection with the Vienna Exhibition, on the fact that Congress has been *compelled* in the past to patronize art, and on the conclusion, which seems to us inevitable, that the Government will be *forced*, in the future, to continue and increase its patronage in this direction.

In the matter of erecting and maintaining public buildings, the subject of exterior and interior decorations, one of very great importance, presents itself to the Government almost every day, in one form or another. But even in relation to what may be termed pure art, scarcely a session of Congress passes without action. Some statue or picture

of considerable cost is purchased, and some native or foreign artist is thus patronized.

4. While we would not place ourselves in the position of condemning wholesale the action of the Government in the past, we may say, without giving just cause of offense to any, that the best artists of our own or of other countries have seldom been patronized, and that some works of very little merit have been paid for and set up in public places to form the taste of those who see no other productions of art. And we may even go so far as to assume that, had the Government adopted years ago some distinct and well-ordered policy in this matter, the amount of money already expended for works of art might have been made to produce results far more satisfactory than now appear.

5. From a well-considered article appearing in the New York Times during the month of May, 1873, in which the claims of a local art-museum were ably urged, we make the following pertinent extract:

"Appropriations of public money to advance the cause of art are not in accordance with the past policy of this country, and hardly yet consonant with public feeling on the subject. Nor does the cultivation of general taste in art appeal to the public in such a way as to command large private contributions from the wealthy and the generous. It does not address itself to the religious feeling of the community, or to the sectarian pride of any religious denomination; it is not regarded as in any way directly a conservator of public morals; it does not touch the charitable and benevolent springs of action, like plans for feeding the hungry and clothing the naked; and its educational purpose is yet so little appreciated that it must inevitably be brushed aside by the great majority of those who, either in their public or private capacity, would listen favorably to applications in behalf of schools and colleges."

Justly recognizing the difficulty of creating and sustaining art-museums on any comprehensive scale through the support of private individuals, the Times expresses its hope, by a very definite implication, that the day is coming when the Government will adopt, and public feeling will sustain, the policy of patronizing art by appropriations of money from the public treasury.

Taking the position of so prominent a journal as expressive of a sentiment of very many people in favor of governmental patronage of art, and as in support of our own belief regarding the proper course to be pursued by Government, we venture to hope that the time is near when the subject will find acceptance with Congress and in the community.

6. On entering the principal portal of the Exhibition at Vienna, the eye was almost immediately taken captive by the specimens of porcelain exhibited in the British department. So striking were some of the articles, and so beautiful in their artistic expression, that a feeling of surprise quickly succeeded the delight with which one turned his attention to this feature of English handiwork.

To undertake even a brief description of the exquisite works presented

by Mintons, Wedgwood, Copeland, and the Royal Porcelain Works at Worcester, would carry us far beyond the limits proposed for this paper, and we can only direct attention to the fact that the advances made within a very few years, in the application of art in the manufacture of English pottery, including articles of common use, as well as those designed for ornament alone, have been enormous; the practical result of which has been a great increase of the production and sale of these articles in the competitive markets of the world.

Passing through the British section, one could not fail to notice a similar development of artistic taste in a great variety of manufactures, such as carpets, furniture, lace, decorations for landscape-gardening, including ornamental iron-work, glass ware, jewelry, paper-hangings and tapestries, tiling and mosaics. And, to one who had been present at earlier international exhibitions, the improvement, from an artistic point of view, in all these branches of production that had taken place within comparatively few years, was distinctly evident.

7. HISTORY OF THE SOUTH KENSINGTON MUSEUM.—While probably few Americans are aware to what cause this sudden and great advance in the application of the fine arts to industry is attributable, it is well understood in England, and so directly has it resulted from wisely-managed governmental patronage of art, bestowed through the medium of the South Kensington Museum, that some account of the origin and scope of that institution will be appropriate in this connection.*

The commencement of the collections forming the art-division of the museum dates from the year 1846, when a committee, appointed by the Board of Trade, recommended that a museum should be "formed in connection with the School of Design at Somerset House, which should exhibit to the students of the school, to inquiring manufacturers, artisans, and the public in general, the practical application of the principles of design in the graceful arrangement of forms and the harmonious combination of colors." Some few specimens were procured in accordance with this recommendation.

8. Numerous objects, illustrating art applied to industry, collected from the Exhibition of 1851, were purchased with a parliamentary grant of £5,000 made to the Board of Trade.

The specimens thus obtained consisted of examples of furniture, metal-work, pottery, and woven fabrics, and were selected by a committee, who, in forming this collection, looked to its becoming the nucleus of a museum of ornamental manufactures.

In 1852, the Department of Practical Art of the Board of Trade was constituted, and the collection already made was publicly exhibited in the rooms of Marlborough House, and in that year the Banduiel collection of pottery and porcelain was acquired.

* We desire to express our indebtedness to Mr. Philip Cunliffe Owen, secretary of the British Commission at the Vienna Exhibition, for his valuable assistance in procuring information as to the history and work of the South Kensington Museum.

In 1854, Parliament made a vote for purchases. Upward of £8,583 was expended by the Department of Science and Art under the authority of the Board of Trade, principally in the purchase of specimens of pottery and porcelain, majolica ware, glass and metal work.

The Gherardine collection of models for sculptures was bought the same year by the chancellor of the exchequer at a cost of £2,110, and placed in the Art Museum.

In 1855, £3,500 were expended in purchases from the Paris Exhibition. The Soulages collection, which was especially rich in majolica ware and specimens of Italian furniture, was brought to England by means of a guarantee-fund, headed by the Prince Consort, in 1856, and finally deposited in the museum.

In the year 1857, the department was transferred from the board of trade to the committee of council on education, and shortly afterward the museum and offices were moved from Marlborough House to South Kensington.

In 1859, numerous objects were purchased in Italy.

In 1860, the Gagli portion of the collection made by the Marquis Campana, consisting of examples of Italian sculpture, was purchased for the sum of £6,000.

In 1861, the sale of the Soltikoff collection took place in Paris, and upward of £5,982 were expended in the purchase of objects from that collection. Other additions were also made in that year.

9. The International Exhibition of 1862 offered opportunities for acquiring specimens of modern art-manufacture, British and foreign, and objects were thus obtained, which cost, in the aggregate, £3,947.

The Paris Universal Exhibition of 1867 afforded further facilities for purchases illustrative of modern scientific discoveries and inventions, and the application of art to manufactures, and a select committee was accordingly appointed by the House of Commons to consider and report on the advisability of making purchases from that exhibition.

After examining various authorities on the subject, the committee reported it was desirable to acquire such objects as those above referred to, at a cost not exceeding £25,000, and to exhibit them in the South Kensington Museum; and, on the report of the committee, the treasury sanctioned an expenditure not exceeding £15,000. A special commission accordingly proceeded to Paris to make selections.

Such have been the principal sources from which the collections of art applied to industry have been formed. In addition, numerous other purchases have been made by means of annual votes of Parliament.

10. The museum has been further enriched by many gifts, notably by the collection of pictures presented by Mr. Sheepshanks, consisting of oil-paintings, water-color paintings, etchings, and drawings. The approximate value of this gift at the time when it was made was £60,000; its present value is not less than £90,000. In addition to many gifts from private individuals, exceeding in the aggregate the value of

£10,000, objects have been presented to the art-division of the museum by Her Majesty the Queen, His Royal Highness the late Prince Consort, His Royal Highness the Crown-Prince of Prussia, His Imperial Majesty the Emperor of the French, His Imperial Majesty the Emperor of Russia, His Highness the Khedive of Egypt, His Imperial Highness the Prince Napoleon, and by various foreign governments.

11. The working-plan of this institution now includes, besides the great central national museum at London, easily accessible to every one visiting or residing in the capital, a system of giving assistance to local schools of art and provincial museums, by loans or gifts of special collections adapted to advance the interests of the manufactures of the particular localities to which they are sent. As for instance, when the remarkable collection of Italian jewelry exhibited by Castellani, at the Paris Exhibition of 1867, was secured by the museum, it was found that most of the articles were in pairs, such as ear-rings, bracelets, &c. Hence it was possible to divide the collection into two parts; one to be retained at London, and the other sent to the schools of art at Birmingham, the seat of the jewelry-trade. And the result soon showed that the suggestive character of the designs and workmanship had proved of great value.

But the museum does not limit itself to the use of duplicates which may happen to come into its hands in its work of distribution to local institutions. The processes of photography, etching, and chromolithography are resorted to for the production of copies that may nearly approach their originals in value as models; and electrotypes, fictile ivories, (consisting of plaster of Paris saturated with wax,) and plaster casts are largely used in the preparation of copies of objects which cannot be duplicated.

Specimens thus produced are available, not only for local institutions in Great Britain, but also for exchange with foreign governments and museums; and a convention was entered into by the representatives of various countries, at the Paris Exhibition of 1867, to promote these exchanges, obtaining permission to reproduce fine works, &c.

The museum is the patron of pure art, as well as the fine arts as applied to manufactures, and, with its splendid galleries, constantly augmenting collections of paintings and statuary, its schools of art and design, and its assistance of local institutions in this feature of its work, is affording an art-education to the people of Great Britain, the practical value and refining influence of which can hardly be too highly estimated.

12. Collections by other governments.—It would be interesting to trace the action of other European governments than that of Great Britain in regard to the matter we are discussing; for, while none have adopted a policy so well adapted to promote practical ends as that developed in the workings of the South Kensington Museum, the patronage of art and the liberal support of public museums have long been acknowledged as a duty by the governments of the Old World.

But such a relation, while it might not be inappropriate in this connection, would expand unnecessarily a paper that is intended to be suggestive rather than exhaustive.

The simple fact, familiar to all who have visited Europe, may, however, be noted, that scarcely a city is without its art-museum, while the wealth of art-treasures in the great capitals can hardly be conceived of by an untraveled person.

13. That the importance of the culture resulting from the presence of such collections in a community should not be appreciated by the people of America at large is not to be wondered at.

We have not yet shaken off the effects of the engrossment of our forefathers in the material interests of life, necessarily given the foremost place by colonists and pioneers.

Nothing that can be called a prevailing taste in the fine arts can be said to exist in America. All is unformed and undeveloped, depending on the effect of what may be termed hap-hazard influence or accidental local instruction.

And while contemplating this state of things in our own country, we can by no means find in any single European nation a condition of affairs that may be unqualifiedly commended.

14. In many of the centers of art, false and immoral standards, that have been working harm for centuries, exist side by side with what is true and ennobling; for the licentiousness of princes and rulers has not spared art from its baleful pollutions.

Scarcely an art-gallery of any importance can be visited in Europe wherein will not be found some picture or statue shamelessly immoral and indelicate in all its suggestions, if not in its actual delineations, which holds its place because of the genius of its author and the beauty of its execution, daily giving forth its degrading lessons, and poisoning the work of those who accept it as a model, an inspiration, or as a suitable object for a copy.

And if the taste in art in America is to be formed by dealers in pictures and statuary, or ignorant millionaires, who make high mechanical excellence the cloak for a traffic evidently in violation of the spirit of the Indecent-Publication Acts, but few years will be necessary to fasten upon us one of the worst of the many evils of European civilization.

15. But not only in its moral aspect is the question of forming correct standards of taste in the community an important one. In a commercial point of view, it is of the greatest moment.

There is a certain inborn sense of the beautiful in man, which enables him to perceive and appreciate, while it does not impart any creative power. As civilization spreads its influences more and more in the world, and man rises above the level of merely supplying his simpler wants, articles of luxury, as they are called, will occupy places of constantly growing importance in the international centers of trade, as it is evident that the nation which can produce such as shall be richest in the expression of beauty will take precedence of the others.

A noteworthy incident occurred at Vienna in connection with the Japanese department of the exhibition, that may serve to illustrate this point.

A large collection of porcelain vases formed a prominent feature in this department. Those from Japan were seized with avidity by purchasers, and greatly preferred to such as were presented from China, although the latter were similar in general style and material. And it was not difficult to account for the greater popularity of the Japanese work over that from the sister empire.

The pottery of Japan is made to assume graceful shapes, and is decorated in a style not in discord with the cultivated taste of Europe; while that of China is grotesque in form, and is embellished with designs that are only to be admired for their transcendent ugliness.

16. A few years ago, France held an undisputed position as above all other nations in productions which involved the fine arts; but, at the present time, England, Germany, and Italy are closely pressing their Gallic neighbor in this respect, and in several branches have already surpassed her.

And it must be owned that in this great and growing interest of international commerce, the United States have hardly yet made a beginning; entering the world's marts as a lavish purchaser only, where she might readily present herself as a respectable competitor.

We will assume as admitted that to prepare the people of any country for sharing in this international trade in articles involving tasteful designs, a general refinement of taste in the fine arts is necessary. Workmen must be capable of appreciating the designs they are called upon to execute, of improving upon them, and of suggesting new subjects and methods of treatment. Artists must be educated and furnished with food for artistic digestion. The public must be so taught as to be able to take an interest in the productions that are to become a source of national wealth and importance.

17. To accomplish all this, museums which shall contain specimens of the art of other lands and other ages may be said to be indispensable. And such institutions cannot exist in a form that shall render them practically effective without governmental patronage.

18. But patronage must not be confounded with support. Art does not need to be *supported* by government in a country where education is so general and wealth so distributed as in the United States.

And yet the very fact of the general dissemination of wealth creates a need for *patronage* on a larger scale than can be expected from individuals, in order to secure for the public the benefits of aggregations of works of art. And it is here that government, especially the Federal Government, has an important duty to perform. We use the word *duty* advisedly; for, unless the Federal Government comes forward as a purchaser of valuable art-productions, golden opportunities, such as have been embraced by the governments of other countries, and notably by

that of Great Britain, will pass neglected, and the people of America will be left culpably and pitifully behind those of Europe in an interest of constantly growing importance.

19. While it would, perhaps, be out of place in this paper to attempt to propose any definite plan of operations to be pursued by Congress in the premises, a few general suggestions may not be inappropriate.

Probably one of the first reflections, that would occur to the minds of members of Congress in this connection, would be that the adoption of some definite policy in regard to patronage of art would relieve them from many embarrassments.

As has been stated already, the Government will unquestionably be forced in the future, to a greater extent even than in the past, to become the patron of art. And if the present method is continued, Members will often be led to sanction, from considerations of policy, what their taste and judgment would naturally condemn. Whereas, if all questions involving expenditures for art-purposes were submitted to, and controlled by, some commission or association that could be safely trusted with them, Congress would be relieved, and the public interests advanced.

We are not prepared to say that some existing institution may not be found suitable to be made the conservator of this important interest. But if none should appear, a commission might be appointed, non-political in its composition, and serving without compensation, in whose hands might be placed such sums as Congress might deem proper to be expended in this direction.

The purchases made by such a commission would inevitably form a nucleus, around which would gather many private collections, and in whose responsible hands individuals would, by will or otherwise, place valuable works of art. Money, too, would be likely to flow in from private sources, and the work would within a few years attain proportions, that might raise it above the necessity of governmental assistance.

No claim of originality is made for the suggestion of the establishment of such an institution at the national capital. It has been a dream of American artists and art-patrons for years, which only needs the placing of well-considered power in wise hands to become an established fact.

We will not say that in America an attempt should be made to copy the South Kensington Museum. The dissimilar conditions of the people of Great Britain and of the United States as to general education and culture would naturally suggest plans of procedure differing in the respective countries.

20. But the marvelous success of this great monument to the wise policy of government, seconded by liberal and judicious private effort, deserves the careful study of such as are interested in the advancement of art in America.

The visitor at South Kensington finds it difficult to believe that the immense assemblage of art-treasures which delight his enchained atten-

tion at every turn has been effected within twenty-five years, and by the expenditure of really insignificant sums on the part of the government. But the fact remains, and reads a pregnant lesson to Americans.

That we could rival the work of the mother country in the same time is not to be expected. But we venture the opinion that the results of an equal number of years of effort, and a corresponding expenditure of money, directed by the many able heads and hands interested in the cultivation of art in America, would delight and astonish the country, and would certainly surpass the expectations of most persons who are accustomed to sneer at the achievements of Americans in matters pertaining to art.

If such a museum must necessarily lack the finest originals of the great works of past centuries, it might, for a very reasonable expenditure, secure faithful copies of the masterpieces of ancient and mediæval art; taking advantage of opportunities to acquire such originals as might be made available through sales or bequests of private collections; while the world's markets of works of living artists would be as accessible to it as to similar institutions in older countries.

In the wide field of art as applied to industry, the establishment of relations with existing museums in foreign countries would, through the system of exchanges now existing in Europe, yield many valuable duplicates and copies of ancient works; and a moderate expenditure of money would secure examples of the best contemporary productions in those countries where this application of art has become a specialty.

21. It is not necessary to pursue further, in this paper, the *modus operandi* of such an institution as we are proposing; it may, however, be suggested that the approaching International Exhibition in Philadelphia in 1876 would afford an opportunity for the purchase of many objects suitable to the forming of art-collections. And the occasion—the completion of the first century of our existence as a nation—would surely be fitting for the inauguration of a distinct policy on the part of the Government in this regard.

It may seem somewhat unpatriotic to speak in this connection of the decadence of our nation, when she seems, in the eyes of the world and of her own people, to be in the very spring-time of life. But we know that as with individuals, so with nations, seeds of constitutional decay may be sown in youth, to bear fatal fruit in middle life. And if we are to be instructed by the course of nations whose civilization exists only as a matter of history, we cannot blind our eyes to the truth that the perversion of the mission of art may be made a cause of rapid national decay. Where art becomes a pander to sensual luxury, morals are weakened and the vital forces of the nation are undermined.

The stern virtues of patriotism and self-denying charity; the patient pursuit of science in the interest of the multitude; the elevation of the mind and its achievements over the senses and their gratification: all these give way before the insidious attacks of art devoted to the por-

trayal of the lower pleasures and degraded to the office of exciting the lower passions.

The fact that in no country or age has art been free from these perverted tendencies, so far from disheartening those who would preserve it from them, as far as possible in America, should serve as a spur and a warning.

We believe every reasonable mind will perceive how important an influence for good might be exerted by a national art-commission, controlling a national museum, with local branches and correspondencies, in which should be exhibited pure and elevating studies and models, and from which should be excluded all that is meretricious and demoralizing.

We commend the subject to the consideration of Congress and its vast constituencies, renewing the expression of our regret that no part of the liberal appropriation for enabling "the people of the United States to participate in the advantages of the exhibition at Vienna" could be used in the purchase of a portion, at least, of the rich art-treasures there exhibited; and expressing the hope that no such opportunity in the future will be neglected by the Government.

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O.

ART OF PRINTING.

G. W. SILCOX.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

THE ART OF PRINTING

AND ON

MANUFACTURES OF PAPER.

BY

GEORGE W. SILCOX,

HONORARY COMMISSIONER OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

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CHAPTER I.

THE ART OF PRINTING.

HISTORY; LETTER-PRESS PRINTING AT VIENNA; EXHIBIT OF THE NEUE FREIE PRESSE; BOOK-PRINTING, D. APPLETON & CO.; EXHIBITS OF MESSRS. GRAHAM, ENNIS, ROWLEY & CHEW, AND HARPEL; THE NATIONAL BUREAU OF ENGRAVING, THE NATIONAL BANK-NOTE COMPANY, HOMER, LEE & CO., GAVIT & CO., H. LEWIS, DOMESTIC LITHOGRAPHIC COMPANY, AND J. M. HIRSCH.

1. HISTORICAL SKETCH.—The history of the art of printing, both by letter-press and lithography, shows that it has taken the most rapid strides since the beginning of the eighteenth century, both in the United States and in Europe. Probably no other department of the industrial arts and sciences has equalled it as an aid in the advancement and enlightenment of the people, and it may undoubtedly be esteemed the greatest of all human inventions. The history of its progress is well known; but it is not without wonder that we look back and reflect upon the rudimentary clumsiness of the art of typography previous to the eighteenth century. The cylinder-press was unknown eighty-four years ago, and was not perfected for practical use until the London Times announced to the public, November 28, 1814, the first paper printed by machinery moved by steam. This press was patented by Mr. Nicholson in 1790, and it was left for succeeding engineers to carry out his views, and to apply them in the most judicious manner to the principles he had laid down in his patent. To the German König is due, however, the distinguished merit of carrying steam-printing into practice. He arrived in London in 1804, and there projected improvements on the common hand-press, but afterward turned his attention to the cylinder-press. The result of his experience was the introduction of a small machine embodying the two most important features of Nicholson's patent, the cylinder and inking-rolls, and, as above stated, it was first applied in printing the London Times.

There was no exhibit of cylinder-presses from the United States at Vienna, and the presses exhibited from other countries were of but very little merit in comparison with previous exhibitions.

2. LETTER-PRESS PRINTING AT VIENNA.—The exhibition of letter-press job-printing was very limited, and we were very much surprised at not finding a better display. Very little attention has been paid to

artistic letter-press printing in Germany, and this in part accounts for the small number of exhibits. The demand in the United States, in this branch of art, has increased so enormously during the past few years that new typographical faces have become as essential to the good printer in the artistic execution of his work as the new styles issued by the hatter. This, in part, has been brought about by their better appreciation by the people.

3. EXHIBIT OF THE NEUE FREIE PRESSE.—The German press has made but very little progress in the typographical or news departments. The Neue Freie Presse of Vienna went to an enormous expense in erecting a large building upon the exhibition-grounds, equipping and furnishing a complete working-office, and issuing a daily newspaper in the interest of the Exhibition, in addition to their regular edition.

Upon the first floor were the compositors, the presses, the stereotyping and engine rooms. Upon the second floor were the rooms of the editor-in-chief and his corps of assistants, the library and other rooms. The press used in this establishment was designed and built expressly for this exhibition, by G. Sigl, in Vienna. It resembles the Bullock press, which was exhibited at Paris in 1867, for the first time, and which attracted attention, as the most remarkable printing-press which had then been invented. Both presses, however, contain Hoe's principle of carrying the stereotype form upon the cylinder. Automatic feeding is also employed upon this (Sigl) press. The paper, after it has been moistened by passing through a shower of fine spray, is made up into a roll containing some 5,000 sheets. The operation of printing, including cutting into proper length, proceeds uninterruptedly until the roll is exhausted. An attachment to this press of two folders, one at each end, which fold the sheets as fast as they are sent from the cylinder, is of very great importance, and was exhibited for the first time. The folding is accomplished by placing these folders at each end of the press, and by an ingenious arrangement of tapes, passing the paper, after leaving the cylinder, first to one and then to the other end, thus keeping the two folders at work, constantly and rapidly, so that finally, when the paper is laid upon the table, it is folded ready for delivery, without the aid of hands, not having been touched from the time it was placed in the roll upon the press until it reached the table. To pass the sheet from one folder to another as it leaves the cylinder, a spring is attached to each set of tapes, and made to connect with the cylinder, so that at each revolution these tapes take up the sheet alternately, and by this simple means all extra handling is avoided.

4. BOOK-PRINTING.—D. APPLETON & CO.—A fair exhibit of book-printing from different countries showed no new development. There was much that was curious, but very little that had any claim to notice for typographical merit. The British Bible Society of London had a very interesting display in the English transept. They exhibited the Bible printed in forty-eight different languages, the New Testament in eighty-seven, and the Old and New Testaments combined in sixty-six.

The exhibit from the United States was by no means what it should have been. The most remarkable and finest specimens of typography and engraving at the Vienna Exhibition were from Messrs. D. Appleton & Co., New York, in their Picturesque America, or American Scenery Illustrated. This work attracted the attention of the jurors by its being the first work of its kind, on so large a scale, ever published with such liberality in design, and with results so magnificent. This work not only represented the results of private enterprise in the United States, but gave the fullest illustrations of the scenery of our country that have yet been produced. It adds another monument to native art, worthy the genius and reputation of its American publishers. The illustrations in this work cost $100,000, and the publishers have received, not only from the American people, but from the leading artists and literary men in Europe, expressions of their gratification and hearty approbation. The engravings consist of steel-plates and wood-cuts. The steel-plates are printed on heavy toned plate-paper; the wood-cuts are of the finest character, and are abundantly interspersed through the text, which is printed on heavy extra calendered and toned paper. This superb work, which it has taken several years to bring to its present state of perfection, consists of complete descriptions and elaborate pictorial illustrations of the most important places and interesting scenery of the greater part of the North American continent. It exhibits the great mountain-ranges, the beautiful lakes, the lovely valleys, the grand primitive forests, the cascades, the magnificent rivers, the towns and cities, in fine all the picturesque scenery of our land, from Canada to the Gulf of Mexico, and from the Atlantic to the Pacific Oceans.

For several years the publishers' artists have been employed in visiting different parts of the United States for the purpose of procuring designs for this work. Hence the views are not only original and trustworthy, but possess that vividness which can only come of personal observation, and portray accurately the various characteristics of each locality.

The volume is something more than a gallery of landscapes; it exhibits the modes of life and methods of traveling of our people, and delineates all the picturesque phases of commerce, as well as the sublime forms of nature; it gives beautiful views of our cities, and portrays the active and brilliant panoramas of our bays and rivers; in short all the marvellously varied characteristics of the scenery of our country are set forth with the utmost fullness, and the work in its completeness forms a splendid pictorial cyclopedia of American life and scenery. The descriptive articles have been written by authors particularly acquainted with the places described; they are accurate and graphic pen-pictures, supplementing the artist's delineation with suitable fullness and effect.

5. Exhibits of Messrs. Graham, Ennis, Rowley & Chew, and Harpel.—L. Graham, of New Orleans, La., and R. & T. A. Ennis, of Saint Louis, Mo., exhibited specimens of job-printing which were very

creditable. Messrs. Rowley & Chew, of Philadelphia, have done much to advance the typographical art in the United States, and their exhibit of admirable specimens of colored printing attracted much attention, especially from those belonging to the trade. The work of Oscar Harpel, of Cincinnati, Ohio, "Typographical Specimens and Illustrations for New Beginners," is the most complete work of its kind which has ever been published. It illustrates good and bad spacing, arrangement of types, punctuation, and press-work, laying before the beginner what required years of practical work and study on the part of the author to learn, and establishing a better and more uniform education for the artistic printer.

6. THE DISPLAY OF THE NATIONAL BUREAU OF ENGRAVING, NATIONAL BANK-NOTE COMPANY, HOMER, LEE & CO., GAVIT & CO., H. LEWIS, DOMESTIC LITHOGRAPHIC COMPANY, AND J. M. HIRSCH.—The Bureau of Engraving and Printing of Washington, and the National Bank-Note Company of New York, were represented by a fine display from these establishments. Homer, Lee & Co., of New York, and Gavit & Co., of Albany, made fine exhibits of engraved visiting and wedding cards and of fashionable notes. Hugh Lewis, of New Orleans, La.; the Domestic Lithographic and Printing Company, Saint Louis, Mo.; and Joseph M. Hirsch, Chicago, Ill., exhibited specimens of lithographic work from the United States.

CHAPTER II

CHROMO-LITHOGRAPHY.

METHOD; HISTORY; PROGRESS OF IMPROVEMENT; COPPER-PLATE COLOR-PRINTING; BAXTER'S OIL PRINTS; REQUISITE FOR THE PRODUCTION OF A GOOD CHROMO; ADVANTAGES; PRANG'S CHROMOS; EXHIBITS OF L. PRANG & CO.

7. METHODS OF THE ART.—The finest and best chromo-lithographs at the Vienna Exhibition were in the United States section. They were exhibited by L. Prang & Co., of Boston, and by Duval & Hunter, of Philadelphia.

Lithography was invented by Alois Senefelder, (born at Prague, Bohemia, November 6, 1771.) The art consists in drawing upon lithographic stone, and in so preparing the drawing made, by means of chemicals, that only the lines will take up the printers' ink. Lithography is the most versatile of all known methods of reproduction. It will admit of flat even tints, and of tints graduated from the darkest shade to the highest light, while it can equally well imitate a crayon-drawing, a line or a stipple engraving. To these artistic advantages is joined another practical advantage, which is absolutely necessary to render color-printing capable of extended application. This is the cheapness and comparative ease of lithographic drawing and printing. The qualities essential to success being thus combined in the lithographic process, it needed only an active hand and brain to turn them to account.

8. HISTORICAL SKETCH.—It is difficult to say to whom the honor of actually inventing chromo-lithography belongs, and, without endeavoring to settle this point here, we may simply say, that the art in its present state is not the result of the labor of any one man, but rather the sum total of the labors of many men, whose time and talents were devoted to working out the problem. It is certain that Senefelder, in his work on lithography, published in 1818, speaks of the possibility of making fac-similes of oil-paintings, and that Weishaupt, in Germany, Engleman, in Alsace, and Sharp, in England, were all engaged about the year 1836, independently of each other, in experiments in color-printing, embodying the principles upon which rests the art of chromo-lithography.

9. PROGRESS OF IMPROVEMENT.—The art of chromo-lithography did not arise suddenly, or without a genesis. It is, on the contrary, the last link in a chain of attempts and experiments all pointing in the same direction, and extending through a period of four hundred years. The aim of these experiments was to find some process by which colored pictures might be multiplied by the press, and thus cheapened so as to be within the reach of the people. The first attempts, the so-called *chiaro-oscuro* prints, the oldest of which appear to have been produced in Germany, were but faint precursors of the brilliant colors of the

recent chromo. They were imitations of drawings, executed in ink of one color, generally of some neutral tint, but of various shades, and were printed from not more than three or four wooden blocks. Several attempts were made at various times to use a greater number of blocks, and to employ positive colors; but no successful results were obtained, as the peculiarities of the wood-cut in which the graduations of light and shade could only be expressed by lines of different thickness, or isolated dots, did not allow that complete blending of tints which is necessary in imitating the effect of an oil-painting.

10. COPPER-PLATE COLOR-PRINTING.—Similar and more successful attempts were also made by copper-plate engravers subsequent to the invention of the mezzotint and aquatint processes. Jacob Christophe le Blond (born 1670 in Frankfort-on-the-Main; died 1741 in Paris) is named as the inventor of color-printing from copper plates. A number of artists followed in his footsteps; but although more successful than the wood-engravers, this process being better adapted to the printing of tints, their efforts proved futile in the end, owing principally to the high cost of copper-plate printing.

11. BAXTER'S OIL-PRINTS.—The first person who succeeded in bringing out good colored prints, cheap enough to allow of large and profitable sales, was George Baxter, (1805–1861,) in England. His process consisted in combining wooden blocks and metal plates, a combination which had been employed before, but which he so perfected by manipulating the metal plates in various ways, that the results obtained were superior to anything previously known.

But although the Baxter "oil-prints" were a long step in advance, they still lacked the imperceptible graduation and blending of tints, that depth and body of color, and that general harmony observed in all good paintings, and were, therefore, dry, hard, and thin. It was reserved for lithography to take the final step, and to accomplish what had so long been vainly attempted.

12. REQUISITES FOR THE PRODUCTION OF A GOOD CHROMO.—To produce a good chromo it is necessary to have a good water-color or oil-painting to work from. From this painting an outline drawing is made, by tracing, which serves as a guide to the artist in working the different plates or stones. It is evident that each printing must fit exactly upon each preceding one, if the whole is not to be spoiled; and it is evident that the outline cannot be drawn by hand more than once without material deviation. It must, therefore, be transferred by printing upon all the stones required to complete the picture—one for each color—so as to secure the most unerring exactness. Within these outlines, and upon these different stones, the artist now proceeds to draw the different tints and colors, beginning with the lighter tints and gradually working up by adding one tint or color to the other until the subject, which at first appeared only as a faint shadow, grows more and more discernible, and finally comes out as the exact counterpart of the original. The

number of stones or plates needed to complete the chromo varies of course with the character of the picture to be produced.

13. CHARACTERISTICS OF THE ARTIST.—From this description the difficulties which the chromo-lithographic artist has to contend with may readily be conceived. He must have not only a high degree of skill in drawing, but he must also possess a fine feeling for, and a thorough knowledge of, colors; and when a picture is presented to him he must be able to tell, approximately at least, what number of plates will be required to reproduce it, and in what order the tints and colors must follow each other. Furthermore, when drawing a new stone for a chromo in process of printing, he must not only be able to calculate what effect the tint or color in which the plate is to be printed will have upon the preceding tints or colors, which latter will partly, or perhaps wholly, underlie the new color, but he must also keep in view the tints and colors still to be added, which in their turn will tend to modify all those already printed. Thus it will be seen that the accusation sometimes levelled against chromos, that they are merely mechanical productions, is wholly unfounded. On the contrary, it would be more correct to say that chromo-lithography, in its most perfect state, requires more skill of eye and hand in every department than any other reproductive process known; for even the printer must be endowed with a delicate sense of color and a quick perception of the intentions of the artist-lithographer; otherwise the labor of the latter may be wholly destroyed in the printing.

14.—ADVANTAGE OF CHROMO-LITHOGRAPHY.—The advantage of chromo-lithography to the public lies in the fact that it cheapens good art. Formerly the possession of good pictures was denied to all but the rich. The chromo has put good pictures within the reach of even the slenderest purse. Formerly those of the less fortunate classes, who desired to hide their bare walls, were obliged to content themselves with cheap and, therefore, badly-executed engravings, or with gaudily colored lithographs; now they can decorate their little rooms and parlors with works of art which are substantially the exact counterparts of those owned by their more favored neighbors, and many of which are found in the homes of the wealthiest and most highly-cultivated citizens. Nor can the refining influences of art be overestimated, and it is pleasing to see that the educators of the country have been awakened to the importance of surrounding the children intrusted to their care with the creations of the painter and the sculptor.

15.—INTRODUCTION OF PRANG'S CHROMOS.—Previous to 1865, which dates the commencement of the reproduction of oil-paintings by the process of lithography in the United States, Harch & Kramer, in Berlin, were about the only well-known publishers of oil-prints which were reproductions of oil-paintings. Occasionally a few specimens appeared in the market from London, Paris, Vienna, and Munich, which were more or less successful in execution. England paid almost exclusive

attention to the reproduction of water-color drawings, and does so up to the present time with great success. Harch & Kramer's publications incited Mr. Prang, of Boston, to create in the United States an establighment which should rival in its work, and, if possible, excel, the best in Europe. His plans were laid several years previous to 1865, but were not matured and put in practice until, in that year, he published six Cuban sketches, after Granville Perkins, two landscapes, after A. T. Bricker, and one of the chickens, af er A. T. Tait. Although he received little encouragement from the dealers in pictures, his prospects soon improved when the public became generally possessed with the idea of owning a picture better in many respects than most oil-paintings and of moderate cost. The first two years after the introduction of chromo lithographs there was little opposition to Mr. Prang, but from 1867 to the present time importations from England, France, and Germany have been pouring in, flooding the market with reproductions both good and bad. Prang's chromos p'aced in comparison with those of Harch & Kramer, who are still at the head of the European publishers, have some striking features of superiority. They are richer in color, show less of the dryness of the common lithographic process, and represent more closely the style of the original, the character and general effect of an oil-painting.

16. THEIR CHARACTERISTICS.—Prang's technics differ to some extent from those employed in all other establishments, and especially from those employed in Germany. In Germany they use mainly the crayon process, in connection with asphaltum tints, while Prang relies chiefly upon the robbing-tint process, which allows of more freedom in the treatment of the plates, and gives a richer color in painting. Above all it demands that the artists employed should have a spirit of zeal and ambition in their work in order to give it superiority over the common trade productions.

17. THE LONDON ART JOURNAL ON PRANG'S CHROMOS.—The London Art Journal, in speaking of art in the different countries at the Exhibition, said, that "there are many things in which the New World surpasses the Old; but art, as yet, is not one of them, although many painters of America hold the very highest professional rank, and claim prominent places by the side of the best artists of the European schools. It is in the book of the future, perhaps, that we shall concede their supremacy. When we have examined photographic views better than any produced in England, we have attributed much of their excellence to the climate. We can have no such solace if we fall short of the Americans in the production of chromo-lithographs. Whatever appliances they have we have. The advantage of long experience is with us. They can obtain no aid from colors and pigments that we cannot command; cost is no more a consideration with us than it is with them, and certainly our original pictures are very much superior to theirs. How is it, then, that these numerous art-issues of a famous establishment in Boston startle

us by their merit, and dispose us to admit that they go beyond those of the most eminent publishers in England? Certainly they do so where they profess to be imitations of oil-paintings, although as certainly they lack the refinement and accuracy of those of which we have had so many after Birket Foster. Without instituting comparisons we are bound to describe the chromo-lithographs of Messrs. Prang, of Boston, as of the very greatest excellence, broad, artistic, true, and singularly effective; indeed they may stand in the stead of paintings in any room, and pass muster as valuable samples of art. * * * * * A pair—entitled 'Sunset on the Coast,' and 'The Launching of the Life-boat'—the former by De Haas, well known as one of the best of American marine-painters; the other by Moran, who also holds foremost rank in that department of art, claim our attention. Another pair is 'The Joy of Autumn,' after William Hart, and 'Prairie Flower,' after Jerome Thompson. In the one we have the peculiar tints of the foliage, the Indian-summer costume which the trees put on in America and nowhere else; gorgeous in brilliancy before they drop their leaves, and rest until spring shall summon them to new life and beauty. It would be difficult to find in the whole range of modern art our prints so entirely satisfactory as these."

18.—EXHIBITS OF L. PRANG & CO.—L. Prang & Co., of Boston, exhibit card-chromos comprising a natural-history series which has been devised with a view to training children to observe nature. These chromo prints of animals and plants, represented in their natural colors, and arranged for instruction in object-lessons, are destined to play an important part in our educational system. Their exhibit, both in the educational department and in the American school-house, attracted great attention. It consisted of the following:

ZOOLOGY.—BIRDS.—Swimming-birds: the wild duck on a large plate, and twelve smaller cards.

Wading-birds: the great blue heron on a large plate, and twelve, smaller cards.

Birds of prey: the golden eagle on a large plate, and twelve smaller cards representing the falcon, vulture, and owl families.

Gallinaceous birds, pigeons: the wild turkey on a large plate, and twelve smaller cards.

ZOOLOGY.—QUADRUPEDS.—Cat family: the domestic cat on a large plate, and twelve smaller cards.

Weasel family: the ermine (or sloat) on a large plate, and twelve smaller cards.

Squirrel family: the gray squirrel on a large plate, and twelve smaller cards.

Hollow-horned ruminants: the cow on a large plate, and twelve smaller cards.

Solid-horned and hornless ruminants: the American elk on a large plate, and twelve smaller cards.

BOTANY.—Shapes of roots: twelve small cards representing the shapes of roots.

Shapes of leaves, I, and shapes of leaves, II: two sets of twelve small cards, each representing the typical forms of leaves; two large plates, illustrating the parts of leaves, &c.

Shapes of flowers: twelve small cards representing the typical forms of flowers.

These four sets are intended to be preparatory, and to teach the elements of botanical terminology.

Lily family: a superb lily on a large plate, and twelve smaller cards. Two representatives of the water-lily family are introduced to show their peculiar characteristics.

Pink family: China pink on a large plate, and twelve small cards.

Rose family: the damask-rose on a large plate, and twelve small cards.

CHAPTER III.

LITHOGRAPHY.

SUPERIORITY OF GERMAN LITHOGRAPHIC MATERIALS AND METHODS; DETAILS OF THE PROCESS; THE LITHOGRAPHIC-PRESS OF RÄDER; THE POLISHING-MACHINE; TRANSFERRING DRAWINGS TO THE STONE; PRINTING MUSIC.

19. GERMAN LITHOGRAPHY.—The best lithographic stones are found on the banks of the Elbe, near Konigstein, Saxony, and on the banks of the Danube, near Salenhofen, Bavaria. These stones are composed of lime, clay, and siliceous earth, and are of different colors, some blue, light and pearl gray, reddish, yellowish, greenish, and buff. In selecting these stones, care should be exercised to procure those of a pearl or light-gray shade, which is the hardest, for engraving and chalk-drawings, and yellow, buff stones, which are soft and best adapted to lettering and transferring. Germany has many good points to teach us in the art of lithography, and especially in the cheap illustration of works upon railroads, including construction, building-materials, railroad-signals, roadways, underdraining, forestry, embankments, and bridge-work. Similar work could be done in the United States to the great benefit of builders and of the general public.

20. DETAILS OF THE PROCESS.—In what follows, we shall endeavor to give a descriptive account of the execution of the work in Europe, and to some extent in the United States. When the designs are made by the engineer, a transparent quill, a steel-pen, or a camel-hair brush is used upon transfer-paper, using a pencil upon drawing-paper. This transfer-paper is prepared by taking one part of the best flake-white, one part of isinglass or gelatine, and a little gamboge to give it a yellowish tint. These colors are dissolved in water over a slow fire, strained through double muslin, and laid on in one coat, in a very warm state, with a large flat camel-hair brush, on one side of good sized smooth, thin paper, which, when dry, requires to be passed through the press frequently, over a heated stone. The ink used in drawing upon this paper is composed of two parts of white wax, two parts of shellac, one part of hard-soap, one-half part of tallow, one-fourth part of carbonate of soda, and one part of powdered lamp-black, or better, Paris-black. The paper, after being drawn or written upon with this lithographic-ink, is put for a few minutes, when finished, between damp blotting-paper; a warmed stone is put in the press, the sheet is placed with the coated side upon the stone, and then passed several times through the press. The back of the paper, now adhering to the stone, is then sponged with water,

the stone is turned and passed several times again through the press, in the opposite direction, after which the sheet is softened with water, and rubbed with the fingers until it can be easily removed from the stone. Some gum is then used upon it, and a linen rag, dipped in printing-ink, with the aid of a little water, passed in all directions over the lines till they appear black and clear. The stone is then allowed to cool and is inked up with the roller. It is then very slightly etched, and after being cleaned is ready for use.

21. THE LITHOGRAPHIC-PRESS OF RÄDER.—The new steam-press, which cheapens large editions of these works and enables work to be done much more cheaply than in the United States, is the press which is manufactured and was exhibited by Mr. Räder, of Leipsic. It has a perfect rolling surface and even impression, turning off as clear and clean a sheet as the hand-press. The stone, when prepared, is placed upon a travelling-bed, or a platen, which is adjustable to suit the varying thickness of the stone, and which can also be moved without altering the height by means of set-scews. The bed is made to travel in and out by an arm or long iron rod attached under the end of the bed and to a revolving wheel about three feet in diameter. It lies flat upon a short shaft which connects by gearing to another shaft extending to the outside of the frame-work, and connects with the main shaft by pulleys and belting. The feed-board has the same position as in most cylinder-presses, with adjustable guides and pointing apparatus, securing a perfect register. The fingers are so arranged that there is no danger of their coming in contact with and injuring the stone. The impression-cylinder is never altered in height; the stone must be set instead. The inking-rollers are arranged with fountains, upon the principle of the cylinder letter-press. The roller used in wetting the stone before inking is placed between the inking-rollers and the cylinder, and is made to revolve, as the bed travels, with perfect correspondence, by a fine adjustment of small cog-wheels attached at one end; by its perfect motion with the stone it saves wear and tear upon the transfer, so that 1,000 to 1,500 more impressions may be struck from it. To make the rolling still more effective Mr. Räder has attached another set of rollers upon the platen system, embodying the principles used for all slab-distribution, so that the stone receives an extra rolling at every impression. Water is supplied to the rollers by a sponge-reservoir. The sheets are fed from the table, and, after leaving the cylinder, are taken up by tapes and passed to a fly, and laid upon a table in the rear of the press. No trouble is experienced in the wiping of the ink off upon the stone. We wish to call attention to the cheapness of these presses, and we submit for comparison the price-list, which was furnished by Mr. Räder himself, with the printed price-list of American manufacturers. The cylinder-presses manufactured by Mr. Räder, at Leipsic, turn off from 1,000 to 1,200 per hour. These figures are obtained by personal observation at several visits to the establishment at Leipsic, where sev-

enteen of these presses were at work printing music. The list here given is in German thalers, each equal to about 75 cents United States paper-currency.

	Thalers.
Press No. 1, taking a stone 45 x 60 centimeters	1,500
Press No. 2, taking a stone 60 x 80 centimeters	1,850
Press No. 3, taking a stone 70 x 104 centimeters	2,600

The following is the price-list of a patent lithographic cylinder printing-machine, which, as manufactured in England and the United States, turns off from four hundred to six hundred impressions per hour:

Press No. 1, taking a stone 21 x 26 inches	$4,100 00
Press No. 2, taking a stone 24 x 32 inches	5,100 00
Press No. 3, taking a stone 28 x 40 inches	5,950 00
Press No. 4, taking a stone 32 x 46 inches	7,150 00
Press No. 5, taking a stone 36 x 52 inches	8,600 00
Press No. 6, taking a stone 40 x 60 inches	10,200 00

The simplicity of Mr. Räder's press cheapens the cost of manufacture, and its rapid work may be expected to bring about as great changes as did the letter-press cylinder some years ago.

22. THE POLISHING-MACHINE.—While in Leipsic, a new machine for polishing off the faces of stone, preparing it for the engraver or transferrer was brought to the notice of the writer. It was very simple and very effective, as one machine accomplished the work of ten men. The stone in this press is laid upon a solid table, which is stationary, having a large iron platen suspended over it, and held by an arm extending back some ten feet, and attached to a wheel lying horizontally and supported by a shaft two feet long extending from below, where it is connected by cog-wheels to another shaft driven by pulleys and belting from the main shaft. This arm runs between two round blocks or loose pulleys placed in the center on either side of the arm, so that when set in motion this platen of iron moves backward and forward over the stone, while the blocks or pulleys in the center give it a side motion, at the same rate with that of the revolution of the wheel in the rear, thus making the iron platen travel more slowly over the surface of the stone, and giving it the same motion as when operated by hand. It covers the entire surface of a large stone with a uniform polishing. The stone is supplied with water from pipes properly attached, and an occasional supply of sand is furnished by the attendant. Six of these machines were at work, and only required two men to handle the stones and to accomplish the work of fifty men.

23. TRANSFERRING DRAWING TO THE STONE.—Transferring autographic productions, letters, maps, line-drawings, or music, from copper, steel, and zinc plates, and the retransferring of any work already on the stone, is one of the most important processes of lithography, as it greatly lessens expense without wearing out the original plates. The mode of

preparing transfer-paper for this purpose is to mix three parts of shoemakers' paste (without alum) with one part of best ground plaster of Paris, a little dissolved patent glue, and some tepid water; strain the mixture through double muslin in a common jar, and when cooled spread it with a large flat camel-hair brush over half-sized, rather thick, paper.

An ink used for taking transfers is composed of two spoonfuls of printers' varnish, one and one-half parts of tallow, three parts of brown, hard soap, four parts of brown wax, five parts of shellac, five parts black pitch, and two and one-half parts of powdered lamp-black. The various ingredients are melted for twenty-five minutes, and the mass set on fire, burning fifteen minutes. It is then formed into sticks. When the impressions have been made on the coated paper with the transfer-ink, the transfer to the stone is accomplished by passing through the press, and the impression is perfect.

The chalk or crayon used upon lithographic-stone in making sketches, portraits, &c., is composed of three parts white wax, two parts of hard soap, one part of shellac, one-half part drops of mastic, one part tallow, one-half part of old lard, one-fourth part Venetian turpentine, one-fourth part Brunswick black, one-fourth part carbonate of soda, one and one-half parts of Paris black, properly melted and burned together.

When writing or a drawing has been furnished on stone, and is to be etched, a mixture of two parts of nitric acid and from forty to sixty parts of dissolved gum-arabic is poured over the stone, once or several times, according to the nature of the work. The etching changes the surface of the stone, raising the work on it to a degree scarcely perceptible to the naked eye. The writing or drawing which has been made with greasy ink or chalk is unaffected by the acid, and these protected parts retain the natural property of the stone, the ability to receive printing-ink from the inking rollers. The water only enters those parts of the stone which have been affected by the acid, while the ink adheres only to those parts, however fine they may be, on which the acid could not act in consequence of the unctuous nature of the ink, or chalk, with which the drawing has been done, and which also, being greasy, rejects the water.

24. PRINTING MUSIC.—Another branch of this industry, and the product of which is used in larger quantities by the American people than by all Germany put together, is that of printing music. The German editions have been reduced one-half in cost, during the past three years, by the use of the steam-lithographic cylinder-press.

An edition of Beethoven's complete works, of four hundred pages, about the size of an eight-sheet book-paper, which is printed from transfers from the zinc plates, and upon good heavy paper, is retailed throughout Germany for the equivalent of 75 cents, United States paper currency. It is furnished to the wholesale dealer for 37½ cents. Sheet-music is sold there at 12 and 15 cents, which costs from 30 to 75 cents

in the United States. Hundreds of thousands of dollars worth of this music-printing is done for the United States every year, principally in Leipsic. This increasing American demand ought certainly to be supplied at home, particularly as labor, especially skilled labor, is every year demanding higher prices in Europe. The advantage of German manufacturers in this case lies in the advance they have made in the mechanical department.

CHAPTER IV.

THE MANUFACTURE OF PAPER.—ORIENTAL PRINTING.

PAPERS EXHIBITED; ORIENTAL PAPER AND PRINTING; MCNICOL'S MACHINERY; QUALITIES AND PRICES OF STOCK; WALL-PAPER; CHINESE AND JAPANESE PAPERS; MATERIALS AND METHODS OF MANUFACTURE; BRITISH IMITATIONS; PAVEY & CO.'S EXHIBITS; CHARACTERISTICS OF ORIENTAL PRINTING; JAPANESE PICTORIAL PRINTING.

25. MCNICOL'S MACHINERY.—In the manufacture of paper, but little progress has been made in the past few years. Mr. John McNicol, of Glasgow, exhibited some machinery for cheapening the cost of production of wood-paper pulp. He claims by his new process to be able to reduce various descriptions of wood, as fir, pine, poplar, willow, bamboo; and rye, wheat, oat, and rice straw, into paper-pulp suited to the manufacture of all grades of paper, from the finest qualities of writing-paper down to the coarsest printing and packing paper, at very much less cost than that of paper made from rags at present prices. This result is obtained by first cutting the raw material into such lengths and thicknesses as are required, by a special machine, then subjecting it in an alkaline solution of caustic soda, to a temperature of from 360° to 375° F. When the resins and silicates are completely dissolved, and the whole fibre perfectly disintegrated, the mass is taken from the boilers and subjected to hydraulic pressure to extract all, or nearly all, the lye or alkaline solution containing the resins, oils, and turpentine, which, instead of being run off as waste, is evaporated in his patent soda-recovery apparatus or evaporator. Here he reclaims about 70 per cent. of the alkali, which is used over and over again, after decanting in the ordinary way. The pulp is next washed with pure water in a washing-engine, and bleached with solution of chloride of lime in the way in which rags and other fibrous materials are treated. The pulp is then put under hydraulic pressure and dried for the market. It brings at present prices in England from £28 to £38 per ton of dry bleached stuff; for unbleached, pressed from the boiler, £24 to £25 per ton is obtained when dry, or less, in proportion to the amount of moisture it contains. In raising temperature in the boilers containing the alkaline solution and chipped wood, it is necessary to confine the paper, and the steam generated has a pressure of from 150 pounds to 180 pounds per square inch.

26. QUALITIES AND PRICES OF PULP-STOCK.—The following table will show the qualities and the English market-prices of the material required to produce a ton of pulp, its cost, and the manufacturer's profit. One ton bleached dry wood-pulp brings £28.

Materials required to produce the same:

Three tons green wood, at £2	£6 00 0
Eleven hundred-weight caustic soda of 60°, at 18*s*	9 18 0
Five hundred-weight chloride of lime, at 12*s*	3 00 0
Fifteen hundred-weight coals, at 1*s*	0 15 0
Five men's labor, 1 at 4*s*. and 4 at 3*s*. 6*d*. per day	0 18 0
	20 11 0
From this amount deduct 70 per cent. of the alkali, and taking the cost of reclaiming at 20 per cent., this leaves net 50 per cent. of the cost of alkali, originally used, to be deducted	£4 19 0
Net cost per ton dry stuff	15 12 0
Add interest of capital invested, and wear and tear, &c	1 00 0
	16 12 0
Profit per ton	11 08 0

It is claimed that even allowing that the prices of rags at present were to fall, and to reduce the value of chemicals and wood-pulp, there is ample room to admit of a reduction in the price, and still to leave a very handsome profit; and should there be a fall in the value of stuff, chemicals would most probably also be bought at a less price than at present, and thus a compensation would occur for the reduction in the price of rag-stuff. Mr. McNicol states that for reducing the different kinds of straw and grain to a perfect pulp, a temperature of from 312° to 320° of F. is sufficient; consequently the boilers required for pulping such light fibrous materials do not necessarily require to be made quite so strong as those already referred to.

27. Wall-paper exhibited.—The display of wall-papers was most attractive in the French and Austrian transepts. The French patterns were tastefully exhibited, and their exhibitors had the rare faculty of showing that the object of wall-paper is to help to decorate the room, and that it should be considered as so much art-material, and used artistically. All walls, however decorated, should serve as a back-ground to whatever stands in front of them, and they should appear unobtrusively to retire behind the furniture. The rooms we live in should be made the most attractive, and their appearance should be taken into consideration as carefully as the dress. In decorating walls, it must always be kept in mind that they are but enriched back-grounds. Carpets, nowhere used so much as in the United States, should be in harmony with wall-decorations.

28. Chinese and Japanese paper.—While examining the products of industrial art exhibited in the Japanese section, some interesting facts were learned in relation to the manufacture of the Japanese paper.

The methods by which this valuable material can be applied to our own requirements should be better known.

Several novelties in paper intended for decorative purposes have made their appearance in Europe, and visitors to the Vienna Exhibition will remember the very handsome curtains of Japanese paper, exhibited by Pavey, which they passed shortly after entering the English transept from the north.

29. DIFFICULTIES OF MAKING SUCH PAPER IN EUROPE.—About three and a half years ago the Earl of Clarendon requested the British embassador, Sir Henry Parks, to furnish his government information respecting the manufacture of paper in Japan and China. The report rendered by that officer indicated that upward of three hundred kinds of paper are manufactured in Japan and China. The specimens sent by the British ambassador are on exhibition at the South Kensington Museum, in London. The great difficulties which lie in the way of Europeans attempting to manufacture paper in competition with the Japanese, are not the marvellous skill required in the work, but their want of materials. The plants which produce the various kinds of paper will not, or, at all events, do not, grow in Europe or America. The same is true of the plants of which the juices form necessary ingredients in the composition of the various lacquers.

30. MATERIALS AND METHODS OF MANUFACTURE.—In the Japanese and Chinese sections at the Vienna Exhibition were samples of rice-paper, which, for its softness and beautiful finish, could hardly be distinguished from silk. This paper is made from slices of the pith of the plant *Azalia papyrifera.* The pith is obtained from the stems in beautiful cylinders several inches in length. The Chinese workmen apply the blade of a sharp, straight knife to these cylinders of pith, and, turning them round dexterously, pare them from the circumference to the center, making a rolled layer of equal thickness throughout. This is unrolled, and weights are placed upon it, until it is rendered perfectly smooth and flat; sometimes a number are joined together to increase the size of the sheet. It will be seen that this more nearly resembles the ancient papyrus than modern paper; but it is more beautiful than the former, being of a very pure, pearly-white color, and admirably adapted to the peculiar style of painting of the Japanese and Chinese. The ordinary papers of the Japanese, the Chinese, and the East Indians have much resemblance to each other. This similarity arises from the fact that the material used and the method of its manufacture are very much alike. The bark of the paper-mulberry is of nearly the same character. There is little doubt that this plant could be propagated, and that the paper could be manufactured, in our country, had our manufacturers a better knowledge of the peculiarities of growth of the plant and of the mode of preparation of this, which is much superior to our own paper. It is not until the fifth year that the stools or shoots of the plants are available for use.

31. IMITATIONS PRODUCED IN GREAT BRITAIN.—The imitations of these Japanese papers, which have become so popular in Europe in consequence of their cheapness and novelty, are illustrative of the increasing influence of Japanese art.

The "Pavey Patented Felted Fabric Company," (51 Oxford street, West, London,) have taken up this manufacture, and are producing an imitation of Japanese paper for decorative purposes that fully meets the demand of the public. Close examination of their elegant exhibit in the British transept showed this to be an article of general utility, and its production to rank among the important discoveries of the day. This paper is as strong as a piece of cotton cloth. It is made of vegetable materials, as hemp and jute, with a small percentage of animal substance.

32. CHARACTERISTICS OF PRODUCTS MADE BY THE PAVEY PATENTED FELTED FABRIC COMPANY.—These makers have especially adapted this article to furnishing and decorative purposes. It is used for lambrequins, window and bed curtains, tapestry, blinds, valances, &c. It is made and printed in perfect imitation of the most beautiful silk, woolen, and cotton stuffs, as well as of the magnificent brocades of Lyons, the splendid reps, woolen and silk damasks of Paris and Bordeaux, and the pretty cretonnes of Mulhouse, while it retains the peculiar Japanese characteristics. This paper is also used for upholstering furniture, of any description, at one-third the cost of the ordinary goods.

The paper is first formed into an endless roll, and is perfectly white in color. Afterward it is taken to an embossing-machine, which impresses it slightly, and then the design is carefully printed from electrotype-plates, first cast from the wood and formed upon a roller, as in wall-paper printing. At the time of the visit of the writer to the manufactory in England, one of the finest patterns which they had produced, and the design of which had taken several engravers some eight months to execute, was being placed upon the presses.

33. JAPANESE COLORS.—The English workmen use great care, and accurately imitate the Japanese, whose mastery over color is wonderful. In this the English are somewhat deficient. The Japanese artist is aided in his work by the rich colors which the various descriptions of lacquer place at his command. The Japanese red is of a pure, full tone, as we see in numerous specimens of lacquered trays and vases. Their black and gold are perfect. The Aventurine, which resembles the Venetian glass of the same name, is a lacquer full of gold spangles, and is of different kinds. This absolute command of perfectly reliable color is of importance to the artist as well as to the printer.

34. EXHIBITS OF THE PAVEY COMPANY.—The qualities which distinguish this peculiar felted fabric should, the patentees claim, prevent its being considered as a mere imitation of woven fabrics, and should make it a specific manufacture. They think it destined to become an impor-

tant article in the furnishing of houses where good taste and elegance preside.

A pair of lined curtains made up with bands two and a half yards wide by three yards long are retailed at from six to eleven English shillings. Those in imitation of silk, figured with gold and silver, are sold at from nineteen to thirty English shillings per pair. It is also claimed that the fabric, being homogeneous, is easily dusted with a feather brush, and that it is not affected by smoke; that it intercepts the air and dampness from without, is non-absorbent, is not likely to retain contagion, and that with ordinary care it will keep fresh for a period of years, while the expense of washing, &c., is saved.

35. THE ART OF PRINTING IN JAPAN AND CHINA.—This is one of the industrial arts of those countries. Their designs are full of quaint and peculiar pictorial illustrations. Their current literature, which forms the mental diet of the multitude, as shown by their exhibits in these departments, is a system of picture-books, the most artistic series of which are by a school of associated artists, Hofksai being their chief. They are printed in colors or plain, at a single impression, on one side of a light-tinted paper, which doubles to form a leaf, and very often divides the print, cutting in halves the figures, to which accident the artists are quite indifferent.

The requisite delicacy of touch of these impressions, partly due to the softness of the material, seems like the handiwork of Nature herself. These sketch-books and colored albums embody the history, poetry, legends, mythology, myths, arts, trades, costumes, jugglery, magic, science, natural history, in fine the whole life of the people, in a cheap form. They keep alive their appreciation of art. They are taught by the pictorial illustrations, or images of things, rather than by literary descriptions, so that to them the style of the design has the same relative importance that the style of writing has with us. All that is best and worst in their taste, or true and false in their lives, is garnered into these picture-books, which evoke the sympathies of a highly-impressible race, passionately fond of nature.

36. CHINESE AND JAPANESE ALPHABETS.—Some of the Japanese facility of handling the pencil is undoubtedly caught, in its elementary phase, in learning to write the two Japanese alphabets. A delicate brush and dexterous handling are needed to make the bold, incisive strokes, which are just such as come most aptly into their system of drawing. Indeed the *Katakana*, or aristocratic letters, are combined to represent a learned doctor, with a perfect rendering of his dignified air and scholastic costume, while the plebeian *Hirakana* is allegorized into a beggar, in a sketch which is executed equally well. Learning to write becomes, in Japan, the first step in learning to draw, for it gives the same flexibility of stroke to the fingers that fingering the piano gives the musician's touch.

37. HOFKSAI'S ALBUMS.—A glance at one of Hofksai's albums shows

at once the analogy between Japanese writing and drawing. In examining these works a fine sense of humor is seen in Hofksai's plates of a tired porter asleep on the ground, his brawny legs across one another, working harder in his dreams than when awake. It would be difficult to find his superior in depicting gymnasts, fencers, wrestlers, and scenes that call for the utmost muscular exertion and dexterity. He is equally felicitous in limning industry of all kinds. Whatever the subject, it is executed with a realistic swing of the pencil and *naiveté* of expression that commends it to the sight as actual life itself. So simply and with so few strokes and touches, with so much reserved power and so little artifice is the occult mechanism of humanity revealed to us, that we seem to have a clairvoyant insight into the consciousness of the actors. Take up a specimen of India-ink sketches on exhibition, and look at the aerial perspective, rendered by graduations in the twisting of a bunch of tall bamboos. The joints of the canes are simply interstices in the drawing, through which the delicate India paper shows, while the leaves, all disconnected from the parent stalk, would fall to the ground were they real. No two of the indicating strokes are alike. A looser, freer manner of design could not be imagined, yet each leaf has its own physiognomy. Its physiology is perfect, and its action complete, alone, as in the mass. No art could be more artless in execution, or with less of what pre-Raphaelites call "truth of detail," and yet no individual has seen it but has involuntarily exclaimed, "What a perfect study of nature!" In sparing himself the artist has spared the spectator, and has still realized to him a plant swaying in the breezy sunlight, free as nature, and imbued with the poetry of growth. No people know better how to illustrate natural history and atmospherical phenomena than the Japanese, and their prints of birds, fishes, animals, plants, and insects possess an indisputable vivacity and verity of coloring and drawing, which is shown in these highly decorated albums.

38. JAPANESE PICTORIAL-PRINTING.—The Japanese pictorial-printing has a fragmentary aspect in the mass, as they are better pleased with strong tints than whole pictures. We look at a connected series of panoramic views, but each figure may stand independently of the others. Thus they assume no perspective of converging lines, but, instead, flat surfaces, flat outlines, and flat tints. There is no *chiaro-oscuro* or modeling by graduations of light and shade, yet by local massing of their colors, adroit management of horizontal lines, and skillful zigzag approaches, they contrive to lay out before us vast reaches of country and sea, receding in the distance and expanding into space in the most natural manner. Moreover, they are clever in securing atmospheric tone, indicating the time of day or night, the season or the state of the elements, by a nicely graduated harmony of tinting. The local and transitory effect is enhanced by contrasts and combinations of positive brilliant coloring, such as the blossoms of trees and costumes of the period of the year afford. In one of these illustrated albums is a snow-scene. Ex-

panses of blue water, far-off mountains bounding wide intervals of low land, valleys running sharply and tortuously against precipices, large flats of vegetation, with relative distances accentuated by living objects, bridges, boats, and villages, the whole having a high line of horizon illumined by broad strata of varied warm lights, or broken by vapors which mystify the scene: all these features are so combined, varied, and balanced as to merit the designation of a distinct school of landscape.

APPENDIX.

THE MANUFACTURE OF PAPER BARRELS.

EXHIBITS OF J. L. THOMPSON; ADVANTAGES OF PAPER BARRELS; THEIR MANUFACTURE.

39. EXHIBIT OF J. L. THOMPSON.—Mr. J. L. Thompson, of Syracuse, N. Y., exhibited his new paper flour-barrels, cigar-boxes, waste-paper and clothes baskets. These were brought out for the first time about two years ago in the United States. Some doubts naturally arose when attention was first called to this exhibit, and a barrel was shown made of paper. In view of the increasing scarcity of material for wooden barrels, it seems probable that their day of monopoly will soon have passed away. The process of preparing the paper consists in subjecting three layers of paper, (called straw-board,) cemented together, to a hydraulic pressure of more than 100 tons. This produces a compact, solid substance of great resisting power. It is shown by actual test that they resist three times the pressure sustained by wooden barrels. These sheets are run through machinery which dovetails the ends, making them ready for joining, and turns the edges. It is passed through another machine, which gives the cylindrical shape.

40. ADVANTAGES OF THE PAPER BARREL.—The patentee claims, in consequence of the form of the paper barrel being a cylinder instead of a convex wooden shape, a saving of 25 per cent. in packing-space. One hundred and twenty-five paper barrels can be stored in the space that one hundred wooden barrels would occupy. The outside of the barrel, after being ornamented and rendered perfectly air and water proof, is ready to put together. One operator can easily manufacture one hundred and fifty per day, while from fifteen to twenty have been considered a good day's work in making wooden barrels. It is obvious that the paper barrels can be made at less cost. Either wooden or paper heads can be used. The former are nicely turned, and the latter are neatly pressed out and stamped in dies. The hoops are strongly united bands of paper. The appearance of the finished barrel is certainly better than that of the ordinary wooden barrel. One cannot but be impressed with its many advantages over the wooden barrel. Hitherto in shipping flour there has always been a percentage of loss from leakage, caused by the warping and shrinkage of the wooden barrel. This will be done away with, as well as the item of cooperage on shipment. Each part of the barrel, hoop, head, and cylinder, is made complete. Empty barrels can be packed the one within another, and put together as required. Again, the weight of a paper barrel being about one-half that

of a wooden one, this will economize one-half ton in weight on each car-load. This appears an immense advantage in our large exportations of breadstuffs to European markets, as well as in domestic transportations. Cigar-boxes were also shown, made in exact imitation of wooden ones, at much less cost, and paper cases perforated in neat patterns to insure perfect ventilation when used for fruit and vegetables. Waste-paper and clothes baskets, and boxes were exhibited; indeed, the number of uses to which this material can be successfully adapted seems limitless.

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A. H. BROWN.

VIENNA INTERNATIONAL EXHIBITION, 1873.

REPORT

ON

GOVERNMENTAL PRINTING-INSTITUTIONS

IN

EUROPE.

BY

ARTHUR H. BROWN,

HONORARY COMMISSIONER OF THE UNITED STATES.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1875.

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INTRODUCTION.

1. The following report is written more for purposes of comparison than in the hope that it will contain much that is entirely new to Americans familiar with the typographic art. It may, however, embody some suggestions which, having been proved to be of value in the Old World, should be favorably looked upon in the New.

The world naturally looks to that country which has produced a Faust, a Guttenberg, and a Schöffer as the home of typography; as the country in which the highest development of the art of printing should be shown.

2. Partly in consequence of this fact, and partly in compliment to the Government to whose exhibition he was accredited, the writer has selected as the subject of his report the condition of the Imperial Printing-Office of Austria as an exposition of the state of printing in the Germanic States; while the National Printing-Office of France has been selected as the exponent of its highest excellence in the Latin countries.

3. While it is true that the Eastern countries hold, and are likely ever to retain, the lead in the execution of those gorgeous *éditions de luxe*, which are intended for the use of a wealthy few, the Western World is turning its attention to the production of those editions of popular works which shall tell their "plain, unvarnished tale" to the millions. So may it ever be, that America shall lead the way to true civilization, by the elevation of the standard of well-being of the people.

K. K. HOF- UND STAATSDRUCKEREI IN WIEN.

4. The writer is indebted to the *Direktor* for the following statistics and facts:

The Imperial-Royal Court- and State-Printing-Office at Vienna was founded in the year 1804, under the reign of His Majesty the Emperor Francis I. Its first director was Johann Vincenz Degen, Chevalier of Elsenau. It originally occupied several rooms in the third and fourth stories of the Franciscan Convent building, No. 913 (now No. 26) Singerstrasse, Vienna. There were from sixteen to twenty *wooden* hand-presses, and the division for printing state-bonds employed from twelve to twenty-four presses of an improved design. There were eight compositors, forty to fifty pressmen, and six type-founders, showing that, even

at this early period in the history of the office, the importance of a type-foundery connected with a governmental printing-office was fully appreciated. The office was in charge of two foremen and three assistants.

5. The establishment consists at present of the following branches:

(1) The printing-office proper, with six composing-rooms and one press-room, for the printing of the State Law-Gazette in the German, Bohemian, Polish, Ruthenic, Italian, Slavonian, Croat, and Roumanic languages, the general orders, governmental rules and regulations, blanks for the royal ministries, bureaus, and establishments, the stenographic session-reports, the bills for both houses of the *Reichsrath*, for the delegations, and for the general national committee, the publications of the *Kaiserliche Akademie der Wissenschaften*, (Imperial Academy of Sciences,) of the state geological establishment, of the central commission of archæology, and of works in foreign languages.

6. The weight of the type and stereotype-plates now in the office is 9,000 hundred-weight. The type, in actual standing-matter, amounts to more than 16,000 pages, 16mo. The office possesses 33,809 copper-plates of all descriptions, and 14,000 wood-cuts.

In the press-room are 27 cylinder-presses of different constructions, (mainly of the manufacture of König & Bauer.) They are driven by two steam-engines, aggregating 46 horse-power. Besides these, there are 10 hand-presses, 2 hydraulic presses, and 2 paper-cutters. On the same floor is also a room with steam-apparatus for manufacturing rollers.

7. (2) The "credit-division," in which are produced state bonds and obligations, of the value of 1, 5, and 50 gulden, (1 gulden=50 cents;) state lottery-tickets, postage, internal-revenue, telegraph-stamps, and envelopes. In this department, there are 12 power, 16 hand, and 11 copper-plate presses, 2 paper-cutters, 18 perforating, and 15 envelope-folding machines.

8. (3) The lithographic department, for the printing of autographic manuscripts and instructions (circulars) from the several ministries, as well as the lithographic and chromo-lithographic illustrations for the above-mentioned offices, with 1 power and 19 hand-presses, and several pantograph, *relief*, guilloche, and stone-grinding machines.

9. (4) The type-foundery, which is justly considered of great utility, and which should be connected with every governmental establishment of any magnitude. It contains 14 type-founding machines, 5 furnaces, 3 sets of apparatus for plaster-of-Paris and *papier-mâché* stereotyping, 3 planing-machines, 2 circular saws, and apparatus for the manufacture of brass rules. It furnishes yearly, on an average, 1,200 hundred-weight of type, stereotype-plates, spaces, quads, &c. It has at its disposition 35,332 steel and 173,672 copper matrices.

10. (5) The galvanoplastic apparatus is used for the production of electrotype-plates for copper-plate and typographic printing, steel-covered copper-plates, iron electroplates, engravings on zinc, copper, steel, and glass. There are facilities for executing every species of work. In

this department are 21 sets of apparatus, 2 batteries, and 16 copper-zinc elements, which furnish yearly 1,200 plates for the production of state bonds and obligations. All the galvanic plates are covered with iron, as it is found to be the most economical.

11. (6) The photographic department, which has 14 objectives and 16 camera-obscuræ.

(7) The drying and pressing room.

(8) The book-bindery.

(9) The sales-rooms, with 1,500 home-manufactured and commission articles, where an annual business worth some 100,000 gulden is carried on.

(10) The paper-warehouse.

(11) The machine-shop.

(12) The carpenter-shop.

12. All these branches are located in a six-story building, of which a part is still occupied by the priesthood, the whole building having been formerly a convent. The dimensions of this building are as follows:

	Sq. feet.
Main front to the north:	
First story	1,726
Second story	1,883
Second story, (museum)	1,020
Third story	4,050
Fourth story	4,050
Also, in second story	3,285
Southern buildings:	
Basement	1,213
First story	1,213
Second story	1,213
Third story	1,311
Fourth story	1,364
Fifth story	1,418
Sixth story	1,458
Attic, (second division)	1,197
Connecting building:	
First story	2,620
Middle tract:	
First story	2,924
Second floor	2,026
Third floor	2,026
Fourth floor	2,185
Fifth floor	2,845
Side tract:	
First floor	4,000

	Sq. feet.
Northeastern building :	
First floor	930
Second floor	970
Third floor	1,102
Fourth floor	1,177
Fifth floor	1,177
Southeastern building :	
First floor	1,765
Second floor	782
Third floor	899
Fourth floor	899
Fifth floor	899

Other buildings :

Provisional branch, in "*Auf der Wilden*," for the composition of the official report on the world's exhibition; rooms in the so-called "Jacobi Hof," and on the Landstrasse.

From the above figures, it will be seen that the building is a rambling structure, ill adapted to the requirements of a printing-office. Additions having been made as the necessities became apparent, it has taken its present shape. As mentioned before, the building is also used for other purposes.

13. Besides those official publications mentioned, the office is authorized, with the consent and authorization of the ministry of finance, to undertake the execution of such private works as will promote the advancement of science and the diffusion of useful knowledge, or which are otherwise beneficial to the public interest, or which cannot be executed by private establishments on account of insufficiency of the existing mechanical facilities.

The administration type-foundery is authorized, and is frequently called upon, to furnish to private establishments the type of foreign languages, matrices, and stereotype-plates of every description. Requisitions for the steel-covering of copper-plates and the use of the large calendering-machines are also frequent.

Composition of works in foreign languages, which cannot be done by private offices, on account of cost of type, is frequently done at the Imperial Royal Printing-Office, at a reasonable rate, and the press-work is executed by the private offices. Thus, and by all other means in its power, does the State Printing-Office foster and encourage private industry.

14. On the 1st of June, 1873, the following comprehended the entire *personnel* of mechanics and laborers:

Compositors	235
Hand-pressmen	37
Power-pressmen	20

Type-founders	35
Copper-plate printers	70
Book-binders	45
Lithographic printers	43
Lithographic draftsmen	8
Machinists	8
Carpenters	9
Others employed in the different departments, but not classified, of which 107 are women	321
Total	831

15. The 107 women mentioned above are employed in the finishing and packing of type and in the internal-revenue and postage-stamp divisions. Indeed, as the director says, women are employed, and enter into competition with men, "at all work, except such as demands too much physical exertion."

16. The following are the rates of wages paid, in florins or gulden, per week:

Compositors	15—40
Hand-pressmen	14—25
Type-founders	16—30
Book-binders	12—20
Machinists	11—18
Carpenters	12—17
Women, at whatever work employed	4— 9

The salaries of foremen are 1,248 florins, and of proof-readers 832–1,144 florins per annum.

17. Apprentices are under the supervision of one foreman, who is assisted by several workmen as instructors, thus laying a foundation for typographic excellence. The apprentices attend school once a week, where they receive technical instruction. The duration of their apprenticeship is four years; but, where extraordinary ability is shown, a less time is exacted.

18. On the 1st August, 1873, there were in press the following works A Malay-French vocabulary, for Abbé Favre; the second part of The Origin of Languages, by Reinisch; a Hebrew primer for the blind; and the exhibition-catalogue of the Egyptian department. Of course, these are but the principal ones.

In regard to facilities for performing work, the *Direktor* states that a book of 500 pages, 16mo, in brevier, can be completed in sixteen working-hours.

19. In the press-room, there are 26 hand-presses, furnishing 200 impressions per hour; 37 power-presses, of from 1,000 to 4,000 impressions per hour; 1 lithographic power-press, making from 700 to 800 copies

per hour; and 19 lithographic hand-presses, making from 50 to 60 impressions per hour.

König & Bauer's double-cylinder presses are considered best for general work; then single drum-cylinder presses, with two ink-fountains, for tabular, job, and book work. Embossing-presses for job work, and two-color presses for colored work, are also furnished by the above-named firm.

Excellent lithographic power and hand presses are furnished by the firm of Sigl, in Berlin and Vienna.

20. The following is the opinion of the administration in regard to the necessity of a type-foundery:

"In consideration of the immense quantity of type and the numbers of necessary 'sorts,' the type-foundery is a pressing necessity for the institution." "It does not pay, however, to manufacture our own paper or ink, *unless competent men can be obtained.*" All the paper used is sized, and represents a purchasing value of 300,000 florins.

21. In the stereotype-foundery, all the methods of stereotyping are practiced, although the paper-stereotyping (*papier-mâché*) process is used where speed is the great requisite; while the plaster-of-Paris method, or electrotyping process, is considered best when excellence and finish of work are demanded. Works in which there will be no changes in the text, such as laws, blank forms, &c., only are stereotyped.

The following is a statement of the yearly average expenditures and receipts:

	Florins.
Salaries and wages	545,000
Paper	300,000
Fuel, lights, type-matrices, &c	141,000
Total	986,000
The yearly receipts are	1,080,000
Showing a surplus of	94,000

22. The working-hours are from 7 a. m. until 6 p. m., with one hour for dinner. On Sundays and holidays, pressing official work only is done, for which the regular rate is allowed.

23. From the rich and manifold treasury of its productions, the establishment has sent to the exhibition (not, however, in competition) a choice collection of exhibits remarkable for typographic excellence. From the catalogue which was furnished to visitors, we select for enumeration the following:

No. 1. Collection of types of foreign languages, manufactured in the Imperial Royal Court and State Printing-Office since 1804, including Arabic, Armenian, Finnish, Etrurian, Japanese, Chinese, Malay, Phœnician, Ethiopian, &c.

No. 2. Specimens of work in the graphic-art branches, such as wood-

drawing, steel and copper plating, stylography, hyalography, guilloche, and "nature printing," which latter, it may be mentioned, is a specialty with this office.

Nos. 3–20. Works wholly or partly in foreign languages, among which may be mentioned the following:

Chinesisches Wörterbuch; Dictionnaire javanais-français, by Abbé P. Favre; *Die Märchen des Siddi-Kûr, kalmückischer Text, mit Uebersetzung und einem kalmückisch-deutschen Wörterbuche*, by Jülg; *Manuel terminologique français-ottoman*, &c., by B. O. de Schlechta-Wessehrd.

Nos. 21–42. Various German works, as the *Literarisches Jahrbuch des ersten allgemeinen Beamten-Vereines der öster.-ungar. Monarchie*; the first part of a primer for the blind, &c.

Nos. 43–60. Lithographs, (in black and colors,) copper-plates, wood-cuts, galvanographics, and photo-galvanographics—the latter by the inventor, Mr. Paul Pretsch.

The office has also placed on exhibition a varied collection of galvano-plastic reliefs, statuettes, &c., and a model of a power-press for endless paper, invented 1860, and twelve photographs, executed in 1858, representing the old city-gates of Vienna.

It is noteworthy that there is a collection of the productions of this institution on exhibition in the establishment, Singerstrasse, No. 26, where may be seen the press on which the Emperor Joseph II practiced the typographic art.

L'IMPRIMERIE NATIONALE FRANÇAISE.

24. The French National Printing-Office was established in the year 1640, during the reign of Louis XIII, under the title of *L'Imprimerie Royale.* It was founded by the Cardinal Richelieu, and was installed in one of the galleries of the Louvre, under the directorship of M. Sébastien Cramoisy. It experienced reverses, and successes, and changes of title with nearly every change of government. At the close of the revolution, it was called the National Executive Printing-Office; in 1804, the Imperial Printing-Office; in 1814, the Royal Printing-Office, once more; in 1848, the National Printing-Office; in 1852, the Imperial Printing-Office; and in 1872, the title at the head of this article was given it, and this it still retains.

25. It has occupied, since 1809, No. 87, rue Vieille-du-Temple, a number of buildings of various heights, covering a space of ground of nearly 8,500 meters, or 9,306 yards.

The ground-floor of its buildings is occupied by the magazines for paper, which are of considerable extent; the reserves of different characters, comprising 20,000 plates preserved for the periodical re-impression of administrative forms and blanks; the steam-engines, the furnace, the hand-press and power-press rooms. As the figures will show, the former press is in greatest number. The drying-room, in which hot air is used, is also located here.

The second floor is devoted to the administrative and book-keeping services, to the proof and composing rooms, and rooms for composition in all the forms of typography.

On the third floor, all the accessary work is carried on, such as folding, stitching, binding, ruling, &c.

26. The national printing-office is charged by various laws with the execution of the printing of all official documents which are intended for publication. It cannot accept commissions for printing from private parties, except for works printed in Oriental or unusual characters and signs, such as are not generally found in private establishments.

All works ordered by the government are printed here, scientific or other, and in any of the languages of Europe, Asia, or Africa.

Models and plans are designed and executed, and pictures, instructions, circulars, deeds, treasury-notes, passports, playing-cards, postal cards, tax-receipts, internal-revenue stamps of all descriptions, &c., are produced.

27. The number of employés in the different departments is shown in the following table:

Profession.	Males.	Females.
Director	1	......
Foremen and clerks	17	......
Laborers	57	......
Usher, receipt-clerk, and office-boys	12	......
Employés in the foundery	41	......
Compositors	242	......
Hand-pressmen	210	......
Lithographers, designers, and pressmen	44	......
Book-binders	37	......
Clippers, rulers, stampers, &c	30	......
Type-dressers	......	12
Press-feeders	......	39
Calendrers	......	12
Folders and stitchers	......	156
Rulers and apprentices	......	61
Folders and binders	......	50
Total	1,021	

28. The employment of women is preferred in stitching, ruling, gathering, drying, and calendering; in fact, in all work—except composition—in which dexterity rather than physical force is required. Wages are generally governed by the amount of work performed; that is, the system of piece-work has been adopted. These wages—extremely variable, as might be well expected, and governed by the different kinds of works—may be given at from 5 to 10 francs per diem for the men and from 2 to 4½ for the women, the highest rate being not quite $1 a day for the most skilled labor performed by women. The wages are paid at the end of each week.

The regulated hours of work are from 7 o'clock a. m. until 12 m., and from 2 until 7 p. m., or ten hours per diem. Work performed outside of these hours is paid for at the same rates, with the exception that eight hours outside of the regular time is called a day. There is, besides,

allowed for night-work a gratuity of $2\frac{2}{5}$ francs to the men and $1\frac{1}{5}$ francs to the women. This gratuity is divided by the number of hours, (that is, into eighths,) and is only paid proportionally for the number of hours actually accomplished.

Absences, even though authorized, involve a deprivation of pay; this being the case even in regard to national, civic, and religious holidays.

29. The number of works in press at the same time varies considerably; the sitting of the French National Assembly occasioning considerable additional work, as is the case in all governments, our own included.

At other times, there may be as many as fifty works in process of execution, besides an equal number of small jobs.

30. In regard to the facilities for executing work, and to the celerity with which it can be done, it is stated that a book, in 8vo, of 500 pages of solid brevier, can easily, in case of need, be composed, (or "set up,") printed, (or "worked off,") and bound, to the number of 500 copies, within 24 hours.

31. The number and kinds of presses are as follows:

Typographic power-presses.

3 newspaper-presses, called *à réaction;*
3 *en blanc*, printing only one side;
1 printing two colors at once, without changing points;
4 large presses, printing both sides at once;
25 small presses, printing both sides at once;
—
36
also—
72 hand-presses.
—
108 being the total number in use.

The production of the above presses varies, according to the construction of the machines and kind of work to be executed; the different capacities being 500, 750, 800, 900, 1,000, 1,300, and 1,800 impressions an hour.

Besides those above mentioned, there are 1 lithographic power-press, 22 lithographic hand-presses, (7 *format grand monde* and 15 *format jésus et raisin,*) and 2 copper-plate printing-presses.

The better classes of presses are of French manufacture; those of Dutartre and Rebourg & Alauzet.

32. In binding, the kind of leather used is governed entirely by the amount of money allowed; the principal varieties used are Russia leather, morocco, shagreen-morocco, sow-skin, calf-skin, sheep-skin, cloth, and parchment.

The National Printing Office engraves the matrices of, and casts, its own type, (which is done at a great saving of time and expense,) and

buys its paper and ink from outside parties. Its nomenclature of paper comprehends 150 different numbers.

The consumption of paper in 1872 was 280,000 reams, of which nearly one-fourth was calendered. This operation is sometimes performed at the manufactory; but the greater part of it is done in the office, after the sheets have gone through the press.

33. The salaries of foremen and proof-readers vary between 2,500 and 4,000 francs. Those of correctors of the first class vary between 4,000 and 4,800 francs; those of the second class, between 3,000 and 4,000 francs; and those of the third class, between 2,000 and 3,000 francs. Readers of first proofs receive between 6½ and 8 francs per diem.

The National Printing Office admits apprentices for only two branches—those of composition and ruling. The time of apprenticeship is four years, the pay being regulated as follows: the apprentice's services are gratuitous during the first year, and remunerated thereafter at the rate of 1 franc (20 cents) per diem for the second year, 1½ francs per diem for the third year, and 2 francs per diem for the fourth year.

For ruling, the length of apprenticeship has no fixed term, but the time is generally three years. The apprentices are paid by the piece, the amount earned varying between 1 and 2 francs per day.

GENERAL OBSERVATIONS.

34. As far as the observations of the writer went, the exhibition of printing-materials was not creditable to the countries of either hemisphere.

Nothing particularly new was exhibited in the German department.

Spain furnished a half score of books, some few stereotype-plates, and a few specimens of type.

France sent some creditable printing-presses—among them some very fast working card-presses. These latter, however, as well as some in the German department, have degenerated into mere stamping-machines, and the work executed on them is anything but artistic.

The United States did not enter into competition in this line; but had she done so she would easily have distanced all competitors. It is to be hoped that America will show in the Centennial Exhibition such a stride in advance in the "art preservative of all arts" as will astonish the world. She can do so if she will but try.

35. TYPE-SETTING MACHINE.—The most successful type-setting machine noticed was in the office of the London Times. The evidence of its success is found in the fact that the Times employs only about one-third of the number of compositors that a journal of its size should employ, did it have all its composition done by hand.

36. This office also manufactures the celebrated Walter press, which equals, if it does not excel, in point of rapidity and clearness of impression, the best Hoe machines. Here also was observed a new process in casting stereotype-plates, by which they are ribbed on the inside. The

advantage of this, when the plates are worked on such rapidly revolving cylinders, must readily appear to all practical printers and pressmen.

In closing this article, the author would wish to present the matter of the Government manufacturing its own matrices and type. This all the European national printing-offices do; it is even proposed to be done in the National Printing-Office of Egypt, at the head of which a naturalized German-American citizen has been recently placed. Will the Government of the United States lag behind, and allow itself to be excelled by nations comparatively barbarous?

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